THE ETIOLOGY DIAGNOSIS AND THERAPY OF TUBERCULOSIS

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PULMONARY TUBERCULOSIS.

ITS ETIOLOGY, SYMPTOMATOLOGY AND THERAPEUTICS.

—BY—

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PREFATORY NOTE.

This little work on Tuberculosis contains the views of one of the most eminent clinical teachers and practitioners in Europe. It is, I think, the most recent published utterance on the subject. The matter was delivered in the form of lectures to his pupils and consequently some diffuseness and repetitions occur. The translation, though not elegant, is faithful.

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PART FIRST.

THE ETIOLOGY OF TUBERCULOSIS.

CHAPTER I.

THE TUBERCLE BACILLUS—HEREDITARY TRANSMISSION—DIRECT INFECTION.

The radical revolution produced in theories concerning the nature of tuberculosis by the classical researches of Koch has also had a reformatory influence on clinical views. So long as the nature of tuberculosis was unknown, theory drifted hither and thither as the prevailing current carried it. At one time tubercle was held to be a neoplasm, again something specific and infectious, again a product of inflammation. Its origin from bronchial catarrh, pulmonary hemorrhage, pneumonia, inhalation of dust, etc., was asserted and denied with equal vigor. Its contagiousness was at times maintained and at other times rejected. Inheritance alone was always considered to be an unassailable and sure etiological factor; but lately even that has not escaped question.

Through this chaos of theory and empiricism,

Koch's discovery suddenly shot a piercing ray which not only illuminated the very kernel of the subject, but spread light and guidance in every direction. By a single stroke, the old and much debated knot of the nature of tuberculosis was untied, and the parasitic character both of it and of scrofula in all their forms and situations was established.

I remember well the profound impression produced upon the members of the Pharmacopœia Commission by the first demonstration which Koch made in the laboratory of the Imperial Sanitary Bureau. He had not then made public his discovery;* but he graciously yielded to our desires and those of the then chief of the Sanitary Bureau (Dr. Struck), and explained to us his preparations and the manner in which he had made the discovery. In that modest laboratory of the unassuming scholar, we saw one of the greatest puzzles of pathology, the nature of the worst scourge of humanity, unravelled. And how complete, rounded and positive his solution of the problem was became evident when criticism and subsequent investigation found not only nothing important to change, but even scarcely anything of value to add. There was not a weak link in the entire chain of demonstration.

Clinical medicine at once accepted the new doctrine and frankly interested itself in the reconstruction

* He announced it in the *Berliner Klin. Wochenschrift*, 1882, No. 15.—Tr.

of views which it imposed. Every intelligent person, however, saw clearly that there would be many difficulties in the beginning. Various points in the subject of tuberculosis seemed, from the standpoint of the bacillus theory, to be beset by almost insuperable difficulties. Among them stood at the very threshold the question of Inheritability.

In truth, no fact of experience seems so firmly established as *the inheritability of tuberculosis*. Day after day the physician sees this disease reap its harvest among the offspring of tuberculous parents. In infancy scrofulous, in youth tuberculous—that is the history of such children as they grow up and wither away. How can this axiom of experience be made to harmonize with the bacillus doctrine of Koch? Various solutions have been attempted. Thus far, however, most of the attempts involve hypotheses which, though supported by some scattered facts, on the whole lack demonstration.

The transmission of tuberculosis on the side of father is supposed to take place at the moment of conception, by means of spermatozoa which contain bacilli. In behalf of this explanation, nothing more is presented than the fact that bacilli have been found in the testicles of tuberculous men. Transmission from the mother at the time of conception must presuppose an ovum either originally infected with bacilli or become infected during its passage. Furthermore, there is the possibility of a later intra-uterine infection

of the child by the paternal seed or the maternal blood. These hypotheses, however, are only desperate resources. The lack of direct proof of hereditary transmission has stimulated the search for other methods of accounting for family tuberculosis. Sée, in his work on Bacillary Tuberculosis, and Rühle, in his paper read before the Sixth Congress of Clinical Medicine and in his Treatise on Tuberculosis (in my Hand-book of Special Pathology and Therapeutics), have made a notable effort in that direction, namely, to substitute post-fœtal infection for intra-uterine. Such an effort deserves the greatest attention, because much more can be done to liberate mankind from tuberculosis if, instead of heredity which is difficult to influence, we should have to deal with extra-uterine infection, the sources of which seem more easy of recognition and control.

Certainly there are many and obvious ways in which a child may be infected. Close contact with a diseased mother or nurse, the kiss of a tuberculous father, contamination of food with tubercle bacilli, bacillary infection of wounds—all these are sources of infection, and their power is proportioned to the weakness of the infantile organism. Next to direct contagion from the sick, milk containing bacilli or spores is the most likely source of infection. When we consider the frequency of bovine tuberculosis, we must see how great the danger from this source is, especially if the milk be unmixed and exclusively from

a sick cow, or if the udder of the animal should be tuberculous. Food experiments lately made by Bollinger and his pupils have established the noteworthy fact that the milk of tuberculous cows is infectious for Guinea-pigs, even when the udders are entirely healthy and the cows, though afflicted with local pulmonary or pleuritic tuberculosis, are in the best condition of nourishment. Of course, the infectiousness is much diminished by the customary admixture of the milk of infected cattle with that of healthy ones; and it is completely destroyed by boiling for five minutes. People, however, are usually negligent concerning a danger which they do not see. Even in intelligent families too little attention is paid to the source of milk supplied to nurslings, and the regular boiling is often done without due care. A mother who relegates to the cook the task of preparing the baby's milk may be pretty sure that it will not be properly done. Physicians should impress upon mothers the duty of themselves attending to it. Soxhlet's bottles, which prevent any injury to the babe from parasites or chemical action, are the best for the purpose, provided the mother herself attends to the due cleansing of the bottle. Considering everything, as the matter now stands, the exact degree of danger from food cannot yet be determined. Perhaps, indeed, the fear of bacilli and spores in the milk is excessive; but the frequency of tuberculosis of the mesenteric glands in children compels us ever to recur to the thought of

infection from that source. Since, therefore, the infectiousness of milk from tuberculous cows has been demonstrated on suitable animals, and since there is no evidence against the application of that result to the human race, it is the duty of the physician to instruct his patients as to this grave danger.

Many other modes of infection exist in close family life which may simulate hereditary transmission and by which a tuberculous father or mother may exercise an unhealthy influence on the children. Contamination of the dwelling, furniture, utensils or food with sputum is the more likely to cause infection in susceptible children, the smaller the dwellings, the larger the family and the less the well-being and cleanliness are.

However, plausible as these modes of infection seem from a theoretical standpoint, viewed practically they are not of great importance. That is evidenced by statistics and by the daily experience of physicians. Cases of transmission of tuberculosis from the sick to others who come into contact with them, as husband and wife, nurses, attendants, etc., are so extraordinarily rare, that its infectiousness cannot be as serious as has been occasionally asserted on theoretical grounds. In order, therefore, to explain the frequency of the disease in persons descended from tuberculous parents, we must still cling to the idea of heredity, and await a further development of knowledge to clear up the darkness which surrounds it.

A special difficulty connected with the question of heredity lies in *the long latency of tuberculosis in childhood.* If congenital tuberculosis were like syphilis or small-pox, where the babe brings with it into the world the symptoms of the disease, the matter would be easy of solution. But it is not manifest in the newly-born. It is like those rare cases of *syphilis congenita tarda*, the symptoms of which often appear first in the 'teens and the nature of which, whether congenital or post-fœtal, is still a matter of controversy. That tuberculosis may exist and perhaps has existed for years in a child apparently in full health is often learned accidentally. A single swollen gland, carefully extirpated from an otherwise blooming and healthy child, has been found to contain giant cells with bacilli. How long were these in the body? Are there other foci of infection in the glands? Who can answer?

Another fact deserves to be mentioned in this connection. During the last great epidemic of measles in Munich, Bollinger had repeated opportunity, as he told me, to demonstrate on the bodies of children who died of that disease the presence of tubercle bacilli in the lymphatic glands, especially of the root of the lung and the mediastinum, although previous to the sickness the children had been apparently healthy and not at all scrofulous.

This important discovery places in a new light the experience that children often develop tuberculosis

after measles. The infection of measles does not induce the tuberculosis, but it makes manifest the latent disease. Probably, as has been frequently verified in the scrofula of childhood, most cases of tuberculosis are preceded by a latent glandular tuberculosis of years' duration. At any rate, it has not yet been proven that tuberculous infection occurs in conception or in fœtal life. More probably it may occur in in the first or second year of infancy through some slight wound (as many observations would indicate) or through milk containing bacilli or spores, etc. Still, the difficulty always returns, namely, that all these possibilities of infection are realized almost exclusively in the children of parents who are either manifestly or latently tuberculous.

Finally, as proof that tuberculosis is directly contagious for healthy persons, cases of unintentional "tubercular inoculation" have occurred, where a slight injury (such as drawing a tooth, a small cut, etc.) has led to secondary swelling of the neighboring lymphatic glands, and in these glands, after extirpation, giant cells with tubercle bacilli have been found. Such cases, however, are of doubtful value, for the bacilli may have dated from some earlier period and may have merely become manifest by reason of the traumatic lymphadenitis. The value of experimental inoculation must remain doubtful so long as we have no guarantee that the lymphatic system was previously free from bacilli, and for such a guarantee we can scarcely hope.

CHAPTER II.

INHERITED AND ACQUIRED PREDISPOSITION—SOCIAL FOCI OF TUBERCULOSIS.

Experience compels us to acknowledge that the healthy organism has great power of resistance to the bacillus which can make an effective and permanent settlement in the lungs, intestines, etc., only when certain favorable conditions are present. These conditions, this as yet unknown pathological something we call *a predisposition* and mean thereby a certain constitution of the tissues which furnish a suitable soil for the settlement of the bacilli. We cannot at present get along without the supposition of such a predisposition which may be either inherited or acquired. A disposition exists, in fact, for other infectious diseases, as typhus, cholera, dysentery, etc., and why should not one be supposed for the settlement of the tubercle bacilli?

In what consists this predisposition which, next to heredity, plays the greatest role in the etiology of tuberculosis? We do no know. We know, indeed, in a general way, how a man looks who has such an *inherited disposition;* we know what causes may engender the disposition; but we do not as yet know its nature or the morphological, chemical or physiological changes to which it owes its origin. Even with its

external appearance, the so-called *phthisical habitus*, there is often but little to be made. The slender body, the flat chest, the thin limbs, the delicate tinge, the vulnerability of the vessels of the mucous membrane, the tendency to epistaxis and to catarrhal inflammations of the larynx, the frequency of cardiac palpitation and of congestions, the circumscribed redness of the cheeks, etc., all that is in many cases scarcely or not at all noticeable. How many robust young people are tuberculous in spite of their compact bodies, stout muscles and natural color! Here there is still much to be investigated!

As to the *acquired disposition*, all those weakening influences which so plentifully beset human life tend to its acquisition, such as insufficient nourishment, unhealthy dwellings and ways of life, insufficient sleep, lack of fresh air, worry and trouble, care of the sick, night vigils, bodily and mental over-exertion, previous sickness, childbed, etc. Of all these, none are so powerful to weaken the resistance of tissues and cells, as *the lack of fresh air and the insufficiency of out-door muscular exercise.*

The effect of these last-named baneful causes can be best studied in the inmates of prisons, asylums, convents and similar institutions. The curtailment of freedom and the privation of open air entail a row of factors, the potency of which in individuals is not easy to estimate. Among these the following are chiefly to be noted: The air in the closed rooms, and

especially in the dormitories, is not pure; it contains dust and fungi, is poor in oxygen but rich in carbon dioxide and bad odors. On account of the sedentary life, respiration is not deep enough and the lungs are not well expanded. The absence of out-door movement and of vigorous muscular work diminishes assimilation, and reduces the need of nutriment; whilst the monotonous diet impairs the appetite. Often also the quantity and mode of preparation of food are not what they should be. In addition, psychical influences are at work, as: in jails, repentance, longing after freedom and family, etc.; in penitentiaries, the enforced contact with the dregs of mankind; in the cellular prisons, the solitariness of confinement and the absence of all incitement. Here then we have a series of weakening factors, under the influence of which the organism sinks into a depraved condition, and a wide door is opened for the settlement of tubercle bacilli which certainly are ubiquitous in prisons.

That consumption is at home in prisons is generally recognized, but the huge proportions in which the inmates succumb to that disease are not sufficiently known. Figures furnished by Baer in the *Zeitschrift für Klinische Medicin* show a mortality from consumption in prisons three or four times greater than outside. The mortality from it in the race is generally reckoned at one-seventh, that is, about 14 or 15 per cent., but in prisons from 40 to 50 per cent. of the deaths is due to consumption; so that about half die

from tuberculosis. The ratio, however, varies considerably. Thus, the total mortality from consumption in the Austrian prisons during four years amounted to 61 per cent., whilst on the contrary in the prisons of Bavaria, during eight years, it was only 38.2 per cent. The death-rate seems to vary in different institutions with the conditions of the building and of discipline; at any rate it is said that in the cellular system tuberculosis claims fully 60 per cent. of the total mortality.*

It is very noteworthy that the mortality from consumption reaches its maximum only in the later years of confinement. This shows that it is not a matter of simple infection, but that in the majority of cases a long-continued deterioration of the system is necessary for the settlement of the bacilli. Many constitutions, however, having less powers of resistance fall sick much sooner, especially if the change from fresh country air to the prison atmosphere has been very abrupt. That has been frequently observed amongst peasants confined in prison. This observation is confirmed by the statistical reports of French and English military surgeons who have found that the frequency of tuberculous disease and death rapidly diminishes during war with its drills and forced marches, and again largely increases during peace, and especially during winter life in the barracks. A similar danger exists

*See appendix for figures relating to American prisons.—Tr.

for the crowded population of great cities, spending, as they do, their days in dusty and over-crowded workshops and their nights in close and unclean sleeping rooms.

The ratio of tubercular disease among the factory population to that among the rural classes is also very much in favor of the view that the quantity and quality of the inspired air is a decisive factor. In Switzerland, for example, the mortality from consumption in industrial districts exceeds that in rural districts by more than double; in the former it averages 2.5 per thousand, and in mixed populations 1.7, whilst in the purely rural population it is only 1.1 per thousand.

Finally, mortality statistics of elevated localities show definitely that the frequency of consumption is in inverse ratio to the elevation, and that in very high districts (as in the Mexican cities of Mexico, Puebla, Quito, San Luis Potosi and Bogotà, with an elevation ranging from 2,500 to 4,000 meters, or about 8,000 to 13,000 feet) tuberculosis is very rare, and in spite of the hurtfulness of industrial labor and mining is not prevalent among the laboring classes. The rarity of the atmosphere is not to be included among the qualities of an elevated climate which at a height of 500 meters (1640 feet), and still more certainly at 1,000 meters, diminish consumption, for we find the same favorable conditions on the ocean and the steppes. Stress is to be laid rather on the rapid move-

ment of the air and on its freedom from microbes capable of germinating. The examination of the atmosphere for microbes made by Miquel and Freudenreich showed that they were entirely absent at an elevation of 2,000 meters, whilst at 560 meters, or 1827 feet (namely, at Thun*) scarcely any were found. Mareau and Miquel likewise found the atmosphere on the high seas and at certain places on the sea coast almost free from them. Thus the results of bacteriological investigation are in entire accord with medical experience. Other factors may also contribute to the relative immunity of elevated and ocean atmospheres, as atmospheric pressure, velocity of the wind, hygrometric condition, and to a certain extent also the energetic pulmonary gymnastics required by these various telluric and atmospheric conditions.

I shall again speak of this point when discussing the therapeutics of tuberculosis, and I now revert to the social fountains or sources of the disease. Amongst these have already been mentioned prisons and badly arranged barracks. Convents, largely attended educational establishments, seminaries, orphanages, and to a certain extent crowded schools also, become influential starting places of tuberculosis if suitable provision is not made by sanitary regulations (both as to the material edifice and the discipline) to counteract the confinement by plentiful fresh air and

*A town of about 5,000 inhabitants, in the canton of Bern, Switzerland.—Tr.

active out-door exercise. Convents seem to me to be the most unfavorable in this regard and to rank next after prisons, because most of their inmates fall victims to tuberculosis. The life in narrow, ill-ventilated cells, the privation of fresh air, and the complete lack of bodily exercises and other movements which compel deep inspiration, are the chief causes of the disease. The same applies to orphanages, educational institutions and seminaries where the pupils are kept in conventual seclusion and are indulged only to a very limited extent in out-door exercise and play. The reason that the statistics of disease are not higher in such institutions is because the confinement is not too strict and especially because young people do not remain many years in them.

Most constitutions withstand the ill-effects of imprisonment for months and years, and not until a certain degree of deterioration has been reached, do the tubercle bacilli begin their destructive activity. Furthermore, statistics of prison sanitation show that the entrance of tuberculosis is frequently facilitated by inflammatory affections of the respiratory organs, especially by pneumonias which have not undergone complete resolution. Certainly, many of these inflammatory troubles are the consequence of the bacillary invasion, rather than favoring causes of it. But we have frequent opportunity in our hospitals to see cases of pneumonia which in the beginning resemble in all their symptoms genuine croupous pneumonia, and yet

the presence of bacilli in the expectoration shows them to be tuberculous.

The experiment made in hospitals of putting many consumptives partly among the other patients and partly in special wards, is of special value for the question of direct contagiousness. Tuberculous disease either among the other patients or the attendants was not found in any greater proportion than outside. According to Williams' report, the physicians, nurses and employes of the Brompton Hospital for Consumptives (the largest of its kind in the world) do not fall sick of tuberculosis more frequently than the inhabitants of populous cities, and that too in spite of poor ventilation, insufficient cleansing of cuspedores, etc. As a matter of fact, only three or four cases could be attributed to contagion in the hospital. However, we must not attach too much value to these statements, for it is well known that the employes of great hospitals are subject to much changing about, and do not hold their places steadily for years.

The religious orders devoted to the care of the sick manifest a very great tendency to the disease. Except those who nurse patients at home, the members of these orders are allowed by their strict rules but little outdoor exercise; and besides they are subjected to all the other injurious influences which I have described as disposing to tuberculosis, such as exhausting work from early morn till late evening, frequent night watches, limited food, and many re-

ligious exercises; and they enjoy but rare and too brief excursions out of doors and into the country. It is, indeed, not to be wondered that the organism should deteriorate under such a strain and should consequently furnish a suitable soil to the tubercle bacilli. Right here among the Sisters of Charity in our large Munich Hospital (whom we see die young, one after another, of tuberculosis, so that it may be said without hesitation that this disease kills 50 per cent. of them), we observe the onset of the infection without there being any hereditary disposition and simply as a consequence of their hospital labors and of their strict observance of their religious rules. The young girls who enter as novices are almost without exception from the country, hardy, fresh and rosy cheeked. After a few months, or in few cases after a few years, that ominous anæmia, which is the usual forerunner of hemoptysis, sets in. It would be absurd to imagine that all these healthy and fresh country girls are hereditarily disposed to tuberculosis; yet in spite of their healthful constitutions, with frightful regularity one after another falls a victim to consumption. Can any further argument be needed for the direct infectiousness of the disease, for the dangers involved in seclusion from fresh air and outdoor exercise, in the curtailment of sleep, in the lack of rest and recreation—all of which are necessitated by the straining vocation of nursing the sick?

I will return to this subject when speaking of prophylactic treatment. It is so serious that all who are in a position to co-operate in improving these conditions should lay it closely to heart.

[The author's remarks on convents, etc., are of course uttered in a scientific, but friendly, spirit. They do not, however, apply so strictly to similar institutions in this country, which, being of recent origin, are built in accordance with the principles of modern scientific construction.—Tr.]

CHAPTER III.

INVASION OF THE ORGANISM BY BACILLI—ITS DEFENCE—VULNERABILITY OF THE APEX—THEORY OF PHAGOCYTES—THE LARYNX.

I have now described all the conditions which favor the settlement of the tubercle bacillus in the human organism. It remains to briefly state what is known concerning the manner of its settlement, propagation and diffusion, and concerning the resources which the organism possesses for self-protection.

The usual ways by which the bacillus gains admission to the body seem to be through the digestive tract in children and through the respiratory apparatus in adults. But there are probably exceptions. The primary cause of tuberculosis of the intestines and of the mesenteric glands in children would seem to be food containing bacilli; and of pulmonary and bronchial tuberculosis, the direct inspiration of bacilli. To explain why the bacilli fix themselves and develop in those places, we must necessarily postulate a pathological condition of the tissues which furnishes a suitable soil for them. The healthy organism is probably able to free itself easily from pathogenous micro-organisms by the action of its secretory and excretory apparatuses, and by encapsulating them in cells, which very

likely destroys or, at least, curtails their activity. If the body did not possess such means of protection, the maintenance of its integrity in the presence of ubiquitous pathogenic micro-organisms would be impossible. The microbes of tuberculosis especially would be noxious to all men on account of their persistence for longer or shorter periods in their habitats, for example, in the consumptive wards of hospitals. Yet, as I have already mentioned, Dr. Williams has shown that tuberculosis among the physicians, nurses and employes of Brompton Hospital is not more frequent than among city people generally. But where the exposure to infection is attended by a fatal disposition to consumption and there is, as we must suppose, less resistance of the cells to the invasion, there the seeds will be planted and will find the requisite conditions for increase and propagation.

I have said that, as far as is yet known, the protective power of the body lies in the normal function of digestion, in the secretion of the bronchial mucous membrane, and in the energetic activity of its amœboid cells. We may consider it established that normal gastric juice digests or at least sterilizes bacilli introduced with food. On the other hand, disturbances of digestion, neutral or alkaline reaction of the gastric juice, and fermentative or putrefactive changes in the contents of the stomach must open a wide door to their progress.

The invasion of bacteria through the respiratory

tract presents the greatest danger on account of their ubiquity. That the organism does resist the admission of foreign bodies with the inspired air is known from the study of sputum during life and of the lungs *post mortem*. We find particles of dust and other minute foreign bodies taken up by large cells, whose source is not yet ascertained. In my opinion, these cells do not originate in the alveolar epithelium, but they are furnished, as I shall hereafter show, by the bronchial mucous membrane (by its *beaker-cells*) and perhaps also by the sub-epithelial layer. Where dust is only moderately inspired, as among bakers and smiths, or by staying in rooms filled with tobacco, wood or coal smoke, the expectoration will show an abundance of large round cells containing particles of coal. But where the inhalation of dust is continuous as among miners, mirror-polishers, etc., this cell activity is not adequate to the task of its removal, and the dust is rather taken into the alveolar epithelium and lymph stomata and partly stored up in the interstitial tissues and partly carried through the lymphatics to the bronchial glands. The fine observations of Zenker and Merkel on the pulmonary tissue of mirror-polishers impregnated with the dust of "English-red" * furnish the most convincing illustrations of this

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* "English-red" is a powdery deposit in the distillation of sulphuric acid from sub-sulphate of iron (green vitriol). It consists of iron oxide and a little sub-sulphate of iron. It is much used in polishing.—Tr.

condition. The power of resistance of the lungs, the ability to eliminate foreign bodies, is therefore limited, but still very considerable. It is very probable that the number of dust-eating cells and their energy in swallowing foreign particles depend on a certain degree of reactive power in the bronchial mucous membrane and the walls of the alveoli, and that the extrusion of the cells depends on the energy of the movement of the cilia and on the efforts at expectoration. Any diminution in the energy and reaction of the epithelial cells of the respiratory tract is an important factor for the domiciliation of the bacilli. This is shown by, among other things, the lack of reaction observable in the beginning of tuberculous infection, as Baer noticed in prisoners and as we ourselves see in our Sisters of Charity. The patients become thin, anæmic, without appetite or strength. Neither cough, dyspnœa, nor other respiratory trouble is present, yet the physical examination will disclose an infiltration in one or both apices of the lungs. Only the higher grades of cell debilitation (as found in prisons and convents) are characterized by such a deficiency of reactive power, but they entitle us to draw inferences as to the lesser grades.

I will here consider a question which is very important from a practical point of view, namely why *the apices of the lungs are the favorite site of tuberculosis*. That they are is a matter of daily observation among medical men. Hitherto it was generally supposed

that the settlement of the tubercle bacilli by preference there was due to a deficient inspiratory expansion of the parts, producing an insufficient ventilation of the local bronchioles and alveoli and this in turn leading to stagnation of the secretions and inflammatory products. Thus the frequency of apical tuberculosis in persons addicted to a sedentary mode of life, and especially to a stooping posture (as tailors and others) was accounted for.

Hanau has lately promulgated the view, and I think on good grounds, that this local disposition of the apices is due not to deficient inspiration but to *more difficult expiration.* That the apices possess a good power of inspiration is well shown by their condition in cases of anthracosis (miner's lung, grinders' phthisis), occurring in industrial work and produced in Arnold's experiments on animals. In such cases, the apices are the parts soonest and most affected. And as to the effects of a stooping posture, it changes, in men, the physiological costo-abdominal inspiration almost to the costal form, because the downward movement of the diaphragm is impeded by the narrowing of the abdominal cavity; but in women, costal respiration is physiological, so that in their case it is of no avail to suppose an insufficient expansion of the lungs. The weakness of the theory of inspiration lends more probability to the expiratory theory. Mendelssohn first deduced theoretically, and I have shown by observations made on individuals with weak

thoracic muscles, that a backward rush of air occurs in the upper lobes during forced expiration, because the superior part of the thorax is deficient in contractile muscles. Consequently, in coughing, the air not only stagnates and momentarily stands still under the strong pressure, but (what is very important for the subject under consideration) the expectoration of foreign particles and bacteria out of the apices is hindered and the contents of the bronchi are even carried inwards to the alveoli by the reverse current of air. The spiral course of the smallest bronchioles may be in the apices an impediment as much to the aspiration of dust and bacilli as to their expiratory expulsion. At all events, this anatomical condition is not at all favorable but rather is very unfavorable to the movement of inspired particles. I can consequently agree with Hanau that the apices which are relatively most favorable for the inspiration of dust and micro-organisms are also most unfavorable for their expulsion. If once the tubercle bacilli reach them, they find a sort of resting place whence they can press into the lymphatics between the epithelial cells and establish themselves in the sub-epithelial layer.

That bacilli may enter through the lymph and blood routes as well as with the inspired air is beyond question. But in the lungs, such a manner of entrance could be inferred only from a primary infection of the walls of the lymphatics and vessels.

When the bacillus has crowded into the tissues it starts up by virtue of its biological qualities (which we do not yet intimately know) an irritation, and following that an inflammatory reaction. Here, then, begins that struggle between the living cells and the parasites, which has been so much spoken about of late. Naegeli has already characterized the struggle between the bacillus and the organic cells as the process in the infectious diseases, on the issue of which the life, disease or death of the individual depends. The result is determined on one side by the vital energy of the cells and on the other by the infectiousness of the bacillus. If the cells conquer, the bacillus is destroyed before it has time to injure the organism; if, on the contrary, they should be conquered, there is no hinderance to the settlement, growth and diffusion of the bacilli.

This generally accepted view of the nature of infection and the part taken by the living cells in warding it off has undergone a still further development in Metschnikoff's doctrine of phagocytes,* which has much of interest in spite of the ambiguity of the phenomena observed by him.

According to Metschnikoff, the office of defence belongs to the so-called phagocytes which are recruited from the leucocytes and fixed connective tissue cells. The irritation set up by the invasion of the bacilli calls them forth to the battle field and they at once set

Glutton-cells, from φάγος, *glutton*, and κύτος, *cell*. The German is Fresszellen.—Tr.

about devouring the intruders, that is, they take them into their bodies and digest them, thereby rendering them sterile. There are two classes of phagocytes, the large and the small ones (*makrophagen*, *mikrophagen*). Among the former, Metschnikoff places the epitheloid cells of the connective tissue, and among the latter the leucocytes with lobed nuclei (*gelappt kernigen*). In his latest publication (Virchow's *Archiv.*, vol. 107, No. 2) he states that the streptococcus of erysipelas is taken up only by the small phagocytes, and that these latter are then taken into the cell-bodies of the larger ones and there digested. Likewise the gonococcus is devoured only by the small phagocytes, whilst in anthrax in rabbits and Guinea-pigs the bacilli are taken up only by the larger ones. In tuberculosis, both kinds of phagocytes are active in resisting the invasion. The larger ones take as epitheloid and giant cells a prominent part in the contest, but the smaller ones first begin it and also overpower a larger number of invaders. Even in twenty hours after inoculating the subcutaneous tissues of a rabbit or the anterior chamber of its eye with a pure culture of tubercle bacilli, Metschnikoff found many of the small phagocytes entirely gorged with bacilli, that is, at a time when there could not be any reaction on the part of the fixed cells. The larger phagocytes do not take part in the contest until later, inasmuch as they swallow up both single bacilli and dead small phagocytes. In this way characteristic conglomerates are formed, in

which masses of devoured substances are found, so that the nuclei of the large phagocytes are covered up, but still demonstrable.

The theory of phagocytes has, however, met with vigorous opposition in various quarters. Its opponents admit that bacilli are taken up into the bodies of large and small cells; but they see in that no tendency to a cure but only a mechanical intussusception of the bacilli by which these gradually undergo certain changes of form. Metschnikoff holds that the protoplasm of the cells kills the bacilli, which gradually break up, or at least lose their virulence and become incapable of infection.

These observations on the relations of the phagocytes to the invading tubercle bacilli are of special interest for our subject, and we await with great expectation the further contributions which Metschnikoff promises on the subject of tuberculosis, and the discussion which will spring from them.

From a clinical standpoint, it would aid the comprehension of the stages of tubercular infection to suppose that in a healthy organism an invasion of bacilli should be at once overcome and made powerless; that in a predisposed organism with weakened vital energy of the cells, the virulence of the invasion should not be wholly destroyed, but should be temporarily made ineffective by encapsulation in the fixed connective tissue cells; and that in weak organs, their storming in should bear down all opposition and rapidly destroy the individual.

I should call attention also to the possibility of the respiratory tract being flooded by putrefactive products containing bacilli, which being inspired lead to rapid softening of the lungs and sweep the patient away. Such an auto-infection of the previously healthy parts of the lungs furnishes a satisfactory explanation of the widespread tuberculous pneumonias which so frequently develop in the later stages of chronic tuberculosis.

Finally, a word about *laryngeal tuberculosis*. It is almost without exception a secondary affection, that is, an accompaniment of a primary pulmonary tuberculosis. Considering that tuberculosis may be acquired by inhalation, primary laryngeal tuberculosis cannot be set down as impossible. The epithelium, however, seems to furnish a very strong protection against enemies from without. Dr. Kukoff made an anatomical investigation of this point in our pathological institute. He used a freezing-microtome and examined fresh larynxes from consumptives. In no case was he able to detect a crowding in of the bacilli from without, as, for example, from sputum hanging in the larynx; but, on the contrary, he found the epithelium well preserved, and saw the bacilli pushing from the sub-epithelial cellular layer out in the intercellular lymph passages of the epithelium towards the periphery. Nevertheless, there is no doubt that local infection may come from bacilli in the sputum if there is the slightest erosion. That, however, would not

bear upon the *origin* of laryngeal tuberculosis, for which we must have recourse exclusively to the blood and lymph streams in the laryngeal mucous membrane.

The question of the *curability of laryngeal tuberculosis* is now generally decided in the affirmative, that is, in the sense of the foregoing view of the curability of pulmonary tuberculosis. It certainly is not often the case that tuberculous ulcers of the larynx heal, but I am very certain that it is possible, for I have seen several cases quickly heal up under the influence of a general quiescence of the tuberculous process, and when the patients died (after some years from renewed outbreak of the tuberculosis) I was able to note the firm scars of the ulcers. All experienced laryngologists must have observed similar cases.

From all that has been said, it is evident that many questions remain to be answered, before all the conditions of the life, work, and death of the tubercle bacillus become so well known that we shall be able to extirpate this hereditary enemy of the human race. But, thanks to the discovery of Koch, enormous progress has been made during the past six years in the study of the etiology and pathology of tuberculosis. The zeal with which the study is pursued and the strict methods used guarantee further and steady advancement, and in it clinical medicine will as far as possible take an active share.

PART SECOND.

THE DIAGNOSIS OF PULMONARY TUBERCULOSIS.

CHAPTER I.

THE PARALYTIC THORAX—THE APICES

It is not my intention to recapitulate the entire symptomatology of pulmonary tuberculosis. I shall limit myself to some matters which are of practical importance, especially for diagnosis. The reader will perhaps find some new points of view valuable for judging individual cases and for ascertaining therapeutic indications. I first select some of the symptoms made known by physical examination.

Let us consider the *form of the thorax* in pulmonary tuberculosis. Long and flat and with scant antero-posterior diameter, it produces the impression that the arched walls have sunk in; that is, the vertical diameter has been lengthened at the expense of the sterno-vertebral diameter. This impression is intensified by the thin adipose and muscles and by the slight elevation of the wall in inspiration. The phrase "paralytic thorax" aptly expresses the condition.

The prominence of the clavicles is partly due to the meagerness of the soft tissues and becomes very marked by the sinking in of the chest wall over the shrunken apices. The prominence of the shoulder-blades is likewise caused by the scantiness of the fat and the thinness and atony of the trapezeus, rhomboideus, latissimus dorsi, and serratus muscles; but it becomes very pronounced when there is simultaneous kyphosis,* that is, excessive curvature of the upper thoracic vertebræ with compensatory lordosis* of the lower thoracic and lumbar vertebræ—a condition found very frequently in long chests.

The flatness of the thorax and the smallness of its antero-posterior diameter can be clearly seen on lateral inspection when the patient's arms are elevated. Diagrams drawn by means of Woillez's cyrtometer make it still more evident. This instrument is first accurately adjusted to the thorax and then, after its removal and fixation, the circumference of the chest is, by its means, marked out on a large sheet of paper, on which the diameters have been drawn. The result is an imaginary cross-section of the thorax which very clearly shows the difference between the normal and the paralytic forms. Several such sections are herewith presented, but necessarily on a reduced scale—a fact that is to be regretted, because the actual propor-

* Kyphosis is an exaggerated condition of the normal dorsal curve; lordosis is an excessive lumbar curve; and a ateral curvature of the spine is called scoliosis.—Tr.

tions would be very instructive. They are made on a plane through the spinous process of the ninth thoracic vertebra and the base of the processus xiphoideus, and all are from patients between twenty-five and forty years of age. The woman (Fig. 1) and the man (Fig. 2) were cases of advanced phthisis. The normal thorax (Fig. 3) was that of a healthy, low-sized, stoutly-built butcher. For purposes of comparison, an emphysematous thorax is presented in Fig. 4, in which the length of the sterno-vertebral diameter is to be noted. Allowance must be made for the thinness of the chest walls, which, of course, makes the paralytic thorax more pronounced; but, as the cyrtometer is always tightly applied, the discrepancy from this cause cannot be reckoned as more than 1.5 cm. (.6 inch). The principal difference between the normal and the paralytic thorax consists in the diminution of the sterno-vertebral diameter and its proportion to the transverse diameter.

It is of little use to give absolute measurements of the sterno-vertebral diameter in the normal thorax because the size of the thorax varies considerably within the limits of health. One may, however, say that in men of medium size (170 to 175 cm. *i. e.* 66 to 68 inches) the antero-posterior diameter should not be less than twenty centimeters (7.8 inches); in phthisical men, it may be as small as eighteen centimeters (7 inches); and in phthisical women, it may be be reduced even to fifteen centimeters (5.9 inches).

Rühle very properly points out that the paralytic thorax in fat persons who become tuberculous may be concealed at first glance by the amount of adipose

FIG. 1.
Consumptive woman, 28 years old. Narrowing of left side.

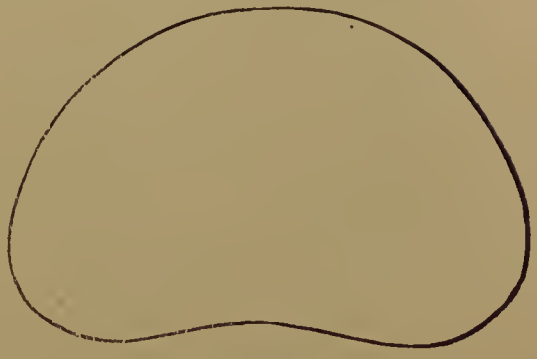

FIG. 2.
Consumptive man, 25 years old. The soft tissues very much emaciated.

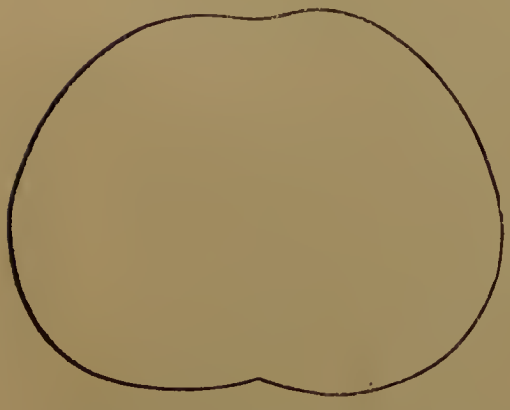

FIG. 3.
Normal thorax, thick muscles. From a man 32 years old.

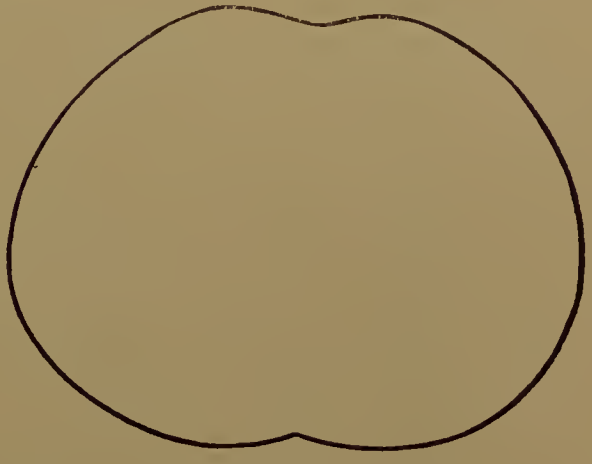

FIG. 4.
Expanded thorax of an emphysematous patient, 40 years old.

tissue. But even in such cases, and especially if there is progressive emaciation, one may by close observation ascertain its presence.

That the paralytic thorax may be found in tall, rapidly grown individuals who are entirely healthy and *not* tuberculous, is certain. Doctors who examine recruits for military service have opportunity often enough to see such cases. Still its occurrence in health is a rarity and ought always excite suspicion of a tuberculous disposition.

In the physical examination, the closest attention should be paid to *the apices of the lungs.* Since they are, in far the greatest number of cases, the locality where the bacilli first lodge, it is to be expected (and experience justifies the expectation) that they should manifest the earliest physical signs of the disease. The anatomical conditions are most favorable for their examination inasmuch as the apex proper lies above the first rib, the clavicle and the upper edge of the scapula, that is, to a certain extent outside the thoracic skeleton and projecting above it. Hence it is possible to accurately mark out the borders and to ascertain to what extent the apices contain air. A sharp outlining of the inflated apices towards the larynx, cervical muscles and vertebral column presents no difficulty to anyone moderately skilled in topographical percussion. Approximately correct results can be had by using the finger to percuss, but the

limits can be accurately defined by the use of my ivory wedge-shaped plessimeter. It is intended for outlining organs and especially for determining the borders of the apices. The instrument (of which a side view, actual size, is given in Fig. 5) is to be applied with its narrow end (2 mm. or .08 inch, wide) to the skin whilst the percussion is made on its broad end (17 mm. or .6 inch).

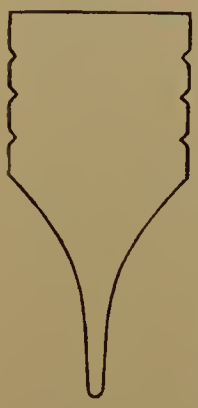

FIG. 5.

On physical grounds which it would take too long to detail, I recomend that percussion be always made from above downwards. Starting from the neck, the edges of the expanded apices should be located, and the boundaries between the dull note of the muscles and bones, the tympanitic note of the larynx and the note of the apices should be marked with pencil or ink. In this way one moves gradually from the larynx to the vertebral column. The boundaries on both sides being thus determined, both apices should be compared with regard to their capacity. Percussion of the supra-clavicular depression should be made from behind towards the front, otherwise the clavicle will be in the way, and the finger cannot be firmly applied in the depression. Corresponding parts of the supra-clavicular grooves should be compared in this manner. In health, the external, middle and innermost parts of these grooves return different notes, the in-

nermost being most intense and the outermost least so. Consequently great care must be taken to compare, in patients, only like parts with each other. Similar precautions must be used in percussing and comparing the supra-spinous regions and the spaces between them and the vertebral column. Results will be more reliable, the more firmly the finger is applied and the more equally percussion is made on it with the middle finger of the right hand. The plessimeter does not fit well into the supra-clavicular grooves and the hammer does not give nearly as fine results as the simple finger; hence their use for those parts is not recommended.

The height of the two apices is surprisingly similar, as is evident from simple inspection. But if one desires to express the height in figures, it is best (in view of the peculiar configuration of the parts) to measure along the edge of the trapezius from the top of the apex to the outer border of the acromion, the arms of the patient being allowed to hang down. The uniformity is all the more wonderful, as it depends on the configuration not only of the neck and upper chest, but also of the scapulæ. Measurements from the tip of the lungs straight down to the clavicles are not reliable. The complete equality of the height of two apices in health naturally causes any departure from the normal proportion in one of them to be very suspicious. Hence the great value of a comparative determination of the height of the apices in the begin-

ning of tuberculosis as well as in its later stages. In the Natural Science Association meeting at Frankfurt, in 1867, I showed to the Section of Medicine, both by photographs and by demonstration on the living subject, the great diagnostic value of these things. I fear, however, that the medical fraternity was not sufficiently impressed with the importance of ascertaining the height of the apices. I should not omit to mention that Prof. Seitz (then at Giessen) had already in 1862 called attention through one of his pupils to the importance of determining this height by percussion.

As to the clinical value of a considerable variation in the height of the apices, I will say that flatness of one or both is usually found with large or small infiltrations at the apex. The shrinkage which causes the flatness occurs in the new connective tissue, which is a product of reactive interstitial pneumonia. As the infiltrate softens and degenerates, together with the alveolar tissue of the infiltrated lobules, the young cicatricial tissue replaces it step by step. In the beginning the defect of tissue is pretty considerable, but it is compensated for by thickening of the pleura and by vicarious distension of the neighboring air-containing pulmonary tissue. The apex suffers most diminution of height when the cicatrix is widespread and ramifying and contains no considerable cavities. Indeed, a considerable flattening of the apices may result favorably in this manner, namely, in cicatriza-

tion and healing, and that all the sooner, if there are no physical signs of cavities. A few schematic figures will illustrate the usual course of nature's curative process in apical tuberculosis. Fig. 6 represents the condition of infiltration; Fig. 7, the advanced softening and cicatrization, with vicarious distension of the adjoining air-holding tissues; and, finally, Fig. 8 shows the arching over of the contracted cicatrix by the compensatory emphysema of the neighboring parts.

FIG. 6,

FIG. 7.

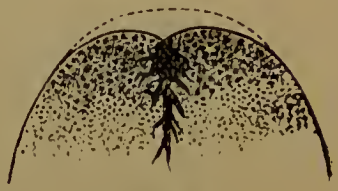

FIG. 8.

In this last stage of simple cicatrization and diminution of the apex, there are usually as yet only very slight dullness to be noticed on percussing, and a heightened or weakened vesicular murmur with prolonged increased or diminished bronchial expiration, *but no rales*—a sign that there are probably no progressive process and no open cavities to keep up softening and secretion.

To a certain extent, the flatness of the apex may be finally compensated for by an increased emphysema of the upper lobes, which are more and more raised up over the cicatrix. This compensation occurs especially when the sunken upper part of the thorax is gradually enlarged by strong inspiration, as has

been observed in pulmonary gymnastics after cicatrization following apical tuberculosis. Here the scaleni muscles count as special factors. The enlargement of the upper part of the thorax must be accompanied by compensatory emphysema of the parts surrounding the cicatrix and by a corresponding elevation of the apices. Such elevations of earlier depressions can be followed clinically with sufficient exactitude. The emphysema around the cicatrix might be characterized as a sort of protective measure against new settlements of bacilli, for experience teaches that emphysematous pulmonary tissue is not a favorable soil for bacilli cultures.

We thus see in what manner the process of spontaneous cure occurs. Frequent exceptions to this course are found. Frequently one or more cavities are met with in the cicatrix. These are filled with firm, inspissated, cheesy secretion, or, communicating with the bronchi and secreting for a long time, they may finally, through progressive cicatrical contraction, end in solidification. Such cavities in the cicatricial tissue, either enclosed or still secreting, are less favorable, inasmuch as they furnish a suitable soil for the development of the bacilli, whilst bacilli in the firm cicatricial tissue have only a counterfeit existence. The cheesy deposits in the cicatrix are usually rich in bacilli and often may undergo softening even at a late period and lead to a local renewal of the trouble or to a general infection of the system. Such caseous foci

and small caverns are volcanoes which may remain quiescent during long years or even during the entire life. Often enough, however, an eruption takes place unexpectedly and to the great surprise of the physician, especially if he have known nothing of the earlier changes and if the patient have reached an advanced age. Acute tuberculosis of old people is commoner than is usually supposed, and the *post mortem* almost always shows remains of the old tuberculous process along side of the new eruption. The existence of such a volcano may be clinically inferred, if the sputum continues to show bacilli, although the individual may otherwise seem entirely restored, and if the dulness of the percussion note over the apex does not fully clear up, as is wont to be the case in simple cicatricial contraction with arching over of the emphysematous neighboring tissue.

There are families in which this benevolent form of tuberculosis (if I may so term it) is hereditary, and in which, consequently, healing of the tubercle focus in the apices and roots of the lungs forms the rule. In the members of such families we may observe the development of the apex trouble at first unilaterally and usually with repeated hemoptyses, and we may afterwards trace the clearing up of the dulness and the contraction of the apex. Then after a long time the other apex takes its turn and we find the same retrograde processes in the same sequence.

If the original tuberculosis which caused the

shrinkage of the apices was not recognized at the proper time, it may be worth while, in order to judge later events (such as the occurrence of a relapse) or to explain special tuberculous affections (as of the vertebræ or genito-urinary tract, or tuberculous diseases in the offspring), to examine the apices as to height and air-contents. Many cases of clear tuberculosis in children, whose parents are apparently healthy and have never been seriously sick, will be explained by such a cicatrized apex in one or other of the parents. If we inquire more closely into such cases we will generally obtain some useful data for the anamnesis, as, for example, that the person when young suffered for a long time with "catarrh," or used to spit blood, or had pleurisy or "intermittent fever which quinine didn't help," etc.

A careful examination of the apex is also very important as regards the question of *primary laryngeal tuberculosis*. It has been repeatedly maintained that the tubercle bacillus may gain admission through the laryngeal mucous membrane as well as the lungs. Cases have been cited where tuberculosis of the larynx existed without the slightest trace of it being found in the thorax. I have seen, however, many cases which at first produced the impression of primary laryngeal tuberculosis, but in which closer investigation of the apices showed cicatricial remains of older processes. So far I have not seen any really convincing case of pure primary tuberculosis of the larynx, but, on the

contrary, I have met frequent cases of sub-acute or chronic laryngeal tuberculosis joined with latent or entirely healed tuberculosis of the shrunken apices.

CHAPTER II.

SPUTUM—BACILLI—ELASTIC FIBRES—MYELIN CELLS—HEMOPTYSIS.

Since Koch's discovery, *the microscopical examination of the sputum* holds the first place in diagnosis. Formerly, in order to diagnose the process of decay, it was required to discover histological elements of the pulmonary tissue in the sputum. However, the demonstration of elastic fibres arranged as in lung structure shows at most only a condition of disturbance, and is not pathognostic of tuberculosis. Koch's discovery gave to the microscopic examination of sputum a much more distinct significance, namely, *where pulmonary tuberculosis exists, tubercle bacilli will be found in the expectoration.* Even should they be scarce, repeated examinations will bring some to light. It may to-day be stated as one of the best established diagnostic axioms that *where tubercule bacilli are found in the sputum, tuberculosis exists;* on the other hand, that *where pulmonary tuberculosis exists, bacilli will appear in the sputum*; and finally, that *in lung affections where skilled examinations exhibit no tubercle bacilli, tuberculosis can be excluded.* At present, however, there are several exceptions to these propositions, namely, acute miliary tuberculosis, in which bacilli have not yet been demonstrated in the sputum, and

obsolete apical tuberculosis, where the callous connective tissue has completely encapsulated the bacilli.

Thus we see the great importance of the bacilli for diagnosis. A single morphological element decides it. Still we must bear in mind the fundamental axiom of diagnosis: *Never base a diagnosis on any single cause but always on the totality of the symptoms.* I do not mean to call in question in the slightest the pathognostic importance of tubercle bacilli in the sputum. In the hands of an expert in bacteriological investigation, a preparation showing bacilli gives absolute warrant for diagnosis. But the investigator must be entirely familiar with the proper method of demonstrating them. Simple as is the method in vogue of Ehrlich-Weigert or Ziehl-Neelsen, the search for and recognition of bacilli require the same experience and care that are necessary in other investigations, if the result is to be trustworthy. An error from inexperience is here more serious, because it concerns a matter in itself decisive of a grave diagnosis. I have seen strange things in the practice of colleagues who though otherwise very capable had not mastered microscopical technique and in consequence made wonderful diagnoses by means of the microscope. Physicians should be very cautious in their conclusions, and in doubtful cases should have their results verified by some scientific authority, as a pathological or clinical institute.*

* See Appendix for method of examining sputum for bacilli.—Tr.

We now approach the question of the relation between *the number of bacilli in the sputum* and the pathological changes which the lungs have undergone. May we infer favorable changes from a decrease in their number, and unfavorable ones from their increase? This question can generally be answered in the affirmative. Numerous bacilli in the sputum denote rapid softening and usually coincide with fever, night-sweats, etc.; few bacilli, on the contrary, are found in chronic tuberculosis and pertain to secretions from cavities. A gradual numerical decrease of bacilli (for example, during a course of climatic treatment) indicates curative changes and will usually be accompanied by corresponding improvement in appetite and weight, freedom from fever, cessation of night-sweats, etc. There are some exceptions to this general statement. Few bacilli are found in progressive softening, if the focus of softening is still separate from the bronchi; and on the other hand numerous bacilli appear in old inactive cavities if their walls should be irritated, for example by any external agent, and their secretion be thereby increased.

Koch's discovery has given a degree of certainty to the diagnosis of pulmonary tuberculosis that can be affirmed of but few diseases. Furthermore, this certainty that tuberculosis is really present in individual cases has improved our knowledge of its curability. The pessimistic standpoint of the old school has been shaken by nothing so much as by Koch's doctrine

which has taught us to recognize many apparently harmless cirrhoses of the lungs as really tuberculous and to trace out their cures. It is consequently not at all justifiable to declare a patient lost in whose sputum bacilli are discovered. Rather we should approach the treatment of tuberculosis with much greater assurance, because our knowledge of therapeutic measures has been so extraordinarily increased and because the hope (which formerly found only timid expression) that the disease could be really cured has been fully verified. The fact that this certainty of diagnosis may be had at the very beginning of the disease has given greater distinctness to therapeutic indications and better foundation to the expectation of cure.

Finally, we are able (and this is of utmost value) to exclude tuberculosis in chronic lung troubles on account of the continued absence of bacilli from the sputum. The diagnosis of simple chronic inflammation of the bronchi and pulmonary tissue, peribronchitis nodosa, anthracosis, cirrhosis and bronchiectasis, pulmonary syphilis and neoplasms of the lungs is rendered easier by the exclusion of tuberculosis; indeed, in many cases it only then becomes possible. So that the clinical investigation of these obscure pulmonary diseases (for example, pulmonary syphilis) has been directed into new paths by the clearing up of the subject of tuberculosis.

I shall now mention some other things which are

found in the microscopical examination of the sputum. Of these I first consider *elastic fibres*. No importance should be attached to single elastic fibres. They constitute a pathognostic sign of tuberculosis only when they present under the microscope the connection and arrangement which they have in pulmonary tissue. This hint will enable us to avoid errors which may arise from accidental admixture with the sputum of bits of meat, or shreds of tendons and connective tissue which may have remained caught in the teeth. The importance of elastic fibres when found in the histological arrangement characteristic of lung tissue is, however, always great. As already said, they indicate only a destruction of the tissues; but when tubercle bacilli are *also* found in the sputum, it speaks for progressive tuberculous softening and against a stationary condition. To distinguish that is sometimes of great value.

When the elastic fibres are but sparingly present, the search for them requires much patience and perseverance. Fenwick's method is recommended as the best. This consists in boiling the sputum with eighteen per cent. caustic soda and then mixing it with three or four times its volume of water; it should be placed in a conical glass and allowed to stand for twenty-four hours, after which the elastic fibres will be found in the deepest layers of the sediment.

The *pigment cells and myelin cells*, which are also found in the sputum of tuberculous persons, deserve

especial notice. In 1872, in his paper on "Pneumonia, Tuberculosis and Consumption," Buhl expressed the opinion that these large pigment-bearing nucleated cells and myelin cells are, if numerous, an infallible sign of beginning desquamative pneumonia—the initial inflammatory stage (according to him) of tuberculous phthisis, and that the quantity of myelin, either free or enclosed in cells, stands in a direct relation to the length of the phthisical process. In the beginning, this view created much perplexity, but it is now, I think, generally considered as refuted. I have long since observed that the sputum of persons who are continually in a hot, dusty atmosphere contains many large pigment cells, fat granules and myelin forms, without the lungs being at all diseased. I have also had repeated occasion to verify after death the integrity of the lung tissue in men who had during life plentifully furnished such sputum. They are mostly persons whose calling or circumstances daily expose them to a hot, smoky atmosphere, as bakers, smiths, bar-room loungers and others.

At my suggestion, Dr. Panizza at one time subjected the whole question to a thorough clinical and experimental investigation, and the result confirms my view as to the unimportance of these morphological elements for the diagnosis of tuberculosis. Myelin and fat granule cells, with or without pigment granules, are found in all lung and bronchial affections, but most constantly and numerously where there is super-

ficial irritation of the breathing surfaces, such as is caused by a heated, smoky atmosphere. Of five hundred healthy and sick men whose sputa were examined by Panizza, pigment-bearing cells and myelin forms were found in eighty-six per cent. of the healthy, only the sero-mucous morning sputum being examined. When the examination was limited to special classes, as smiths, cabinet-makers, cooks, etc., an abundance of these cells was found in ninety per cent. of them. Even after such persons had been in the hospital for a long time the cells, though somewhat decreased in quantity, did not entirely disappear. Panizza was also often able to establish the integrity of the lung tissue in some of the patients who had died of other diseases. Consequently the occurrence of myelin and pigment in the sputum must be considered a phenomenon compatible with health; though when very numerous these elements indicate in general an irritated condition of the breathing surfaces.

As to the origin of myelin and myelin cells, Panizza was led by his researches on the respiratory mucous membrane of the living frog to the view that myelin is identical with mucin which is insoluble in water but swells up in it. According to him, this mucin is a secretion of the beaker cells lying between the ciliated epithelial cells and it is poured out abundantly on slight irritation, as, for example, by the admission of water. At first spherical shaped, it presses by amœboid movements up on the surface and seizes

the pigment granules which are lodged there, and then, having acquired a delicate enclosing membrane, it is pushed outwards as myelin and pigment cells by the movement of the cilia.

It is not to be disputed that where there is continual irritation of the respiratory apparatus, as in trades associated with dusty atmospheres, the alveolar epithelial cells may also take up pigment and appear in the sputum as large pigment-bearing myelin cells. But there is no conclusive reason for ascribing all such elements in the expectoration to the proliferating alveolar epithelium. At any rate, it is much easier to suppose that the largest part of the dust particles remain clinging to the surface of the mucous membrane and are there taken up by cellular elements or elements which later receive the cell form.

To be sure, this does not settle the very interesting question of the origin of pigment-bearing and myelin cells. That question, and in fact the entire subject of bronchial secretion and expectoration, need further investigation and elucidation. I have been constrained, however, to show that the presence in the sputum of abundant pigment-bearing and myelin cells and free myelin has no pathognostic significance for pulmonary tuberculosis; but that it is to be considered in a general way as an indication of an irritated condition of the breathing surfaces.

Some remarks may be here added on *hemoptysis*. It is to be considered as established that the first

hemorrhage in tuberculosis does not come from healthy lung tissue but from diseased lobules; and the view that a primary hemorrhage may start up phthisis can be considered as definitely set aside. The pathological conditions in a tuberculous lung which lead to hemorrhage may be very different. From a clinical standpoint I would distinguish two principal classes: First, hemorrhages which are due to progressive changes and above all to softening consequent on coagulation necrosis; and secondly, such as arise from a pronounced retrograde tendency of the local affection. Whilst hemoptysis at the beginning of tuberculosis and at the advent of secondary outbreaks is serious, its significance, even though frequently repeated, is very slight when there is a decided tendency to healing. In the former case, softening and decay of the tissue is the essential cause; in the latter on the contrary, the bleeding is due to the disturbance of the circulation caused by the cirrhotic shrinkage of the tissues and to the most trifling changes in the walls of cavities. From this point of view, one may say with some degree of authority that habitual blood-spitters are not the worst cases for treatment, but rather that they belong to a favorable class, provided, however, that there is a general retrograde tendency.

CHAPTER III.

FEVER—IDIO-MUSCULAR TETANUS—CONTRACTION WAVES.

Since the thermometer has come into use as an indispensable domestic guide, at least among all half-way cultivated families, we are pretty well informed as to the course of *fever* in tuberculosis. Sick people generally take their temperature more frequently than is necessary. Every slight disturbance, every discomfort causes a resort to the thermometer. That is of advantage to medical observation, so long as the disease has not progressed very far; but in the later stages it is bad, inasmuch as the permanence of high temperature produces a depressing effect on the patient. Hence it is advisable, in advanced stages, to limit or entirely suspend the taking of temperature.

The significance of fever in tuberculosis is always very great. Constant high temperature denotes a progress of the bacillary and inflammatory process; whilst continued apyrexia corresponds to a retrogressive tendency of the disease. The cause of the fever is always to be sought for in the local changes: on one hand, in the multiplication of bacilli, the reactive inflammation of the lung tissue and in the fever-exciting products of both; on the other hand, very probably also in the absorption of products of decay

from the focus of softening and in the chemical products of secondary colonies of cocci, about the bearing of which on local and general disturbance in pulmonary tuberculosis, we in fact know very little. Viewed in their extremes, we may compare the continuous fever of acute infiltrations with the fever of pneumonia, and the erratic or regularly occurring exacerbations of the late stages with that of septic infection. Between these extremes lie many intermediate forms, among which the slight febrile excitement, which often lasts for months, is least clearly due to the local changes. In general, we may observe in this disease, just as in severe fevers, a remission entirely or almost down to normal in the morning and an exacerbation towards mid-day or in the afternoon.

Leaving aside the higher degrees of absorption fever, the fever curve of tuberculosis generally corresponds to the curve of protracted acute and subacute infectious fevers; but there is not the same regularity of movement, such as is observed, for example, in typhus. This is best shown by hourly observations continued during the twenty-four hours. Just as in the curve of typhoid fever, so here double-crested curves are usually marked, corresponding to the late forenoon and the afternoon, whilst after six o'clock P. M. the temperature declines to the morning minimum. In many cases, the twenty-four hours' curve shows only one crest in the afternoon, or more rarely in the forenoon. Triple-peaked curves are

found very seldom, and then one of the crests corresponds with midnight.

The more the symptoms are those of absorption fever, the greater will be the difference between the temperature of the remission and the exacerbation. The higher the latter, the lower the former—not only down to normal, but often a degree or two below it. To explain this access of fever, we must suppose, as in the septic fevers, that either the absorption of pyrogenic matter into the circulation occurs with some regularity and calls forth an explosive reaction of the organism, or else that as soon as it has sufficiently accumulated in the blood, it causes an excitation of the nerve centre for temperature and produces a sort of cumulative effect. Although, as appears from what I have said, we cannot assign a distinctive type to the fever of tuberculosis, it is still worth while to impress on our minds the usual manner of its course.

I wish next to speak of an interesting phenomenon which was long held to have a diagnostic value, and which occurs usually, if not exclusively, in tuberculous phthisis. I mean the so-called *idio-muscular contraction*,* which owes its origin to the abnormal

* From the Greek ἴδιος, peculiar. This phenomenon, first observed by Graves and Stokes, was described by Tait, in the Dublin Journal of Medical Sciences (Vol. LII, p. 316), and called by him "Myoidema." To elicit it, the percussion must be immediate, *i. e.*, without the interposition of plessimeter or finger.—Tr.

mechanical irritability of the emaciated muscles. If we strike firmly with the percussion hammer or the tip of the finger on the pectoral muscle of an emaciated consumptive near the sternum, we do not get that rapid movement through the extent of the fasciculus of the muscle which occurs in health, but instead a rather hard *muscular tumor*, corresponding to the size and form of the percussing body, appears and quickly disappears. This brief circumscribed tetanus may be combined with the normal muscular movement, but such a combination is not constant. It may be simultaneously elicited at different parts of the muscle, or even of the same fasciculus, by using all the fingers in percussion.

In many consumptives, besides this idio-muscular tetanus, another notable phenomenon occurs. When the tumor forms, very superficial and delicate *contraction waves* pass from it on each side across the muscle. They run perpendicular to the long axis of the fasciculus and mark the extent of the irritation or force applied. They are best seen if one draw the handle of the hammer firmly and quickly across the muscle parallel to the sternum. Two delicate waves, corresponding in width to the length of the streak, are formed, one moving towards the sternum and the other towards the humerus, and both gradually decreasing in size. If two or more such lines are drawn parallel to one another, each will give off two lateral waves; and it is noticed on close observation that,

when any two opposing waves meet, they do not die out but they pass on, one over the other. The more advanced the phthisis and the more wasted the adipose tissue and muscles, the more clearly and constantly will this phenomenon be elicited.

The phenomenon of myoidema was long known to physiologists, but frequent observation of it in consumptives first led the English surgeon, Lawson Tait, to think it was a pathognostic sign of phthisis, and in fact of the softening stage. Later observers have verified its occurrence in advanced phthisis without, however, giving full assent to Tait's opinion of its pathognostic significance. In conjunction with two of my pupils, Dr. von Millbacher and Dr. Stadelmann, I have subjected the matter to a close investigation. Our conclusions were briefly the following:

1. The idio-muscular convulsion occurs only when the adipose tissue is completely wasted and the muscles are extremely emaciated. It can consequently be elicited in all patients in whom these conditions are verified and of course especially in consumptives in whom emaciation is usually very great. We found it to occur in other diseases which cause great emaciation, as in the fourth or fifth week of abdominal typhus, in cases of neoplasms, etc.

2. For demonstrating the phenomenon, only those muscles are suitable which lie upon osseous structures against which they can be firmly compressed by the stroke. The muscle best adapted is

the broad pectoralis major, but we found it in other muscles with a hard back-ground, as, for example, the supra-spinatus, deltoideus, extensor digitorum communis, tibialis anticus, etc.

3. We succeeded a few times in eliciting a weak tumor formation in men apparently healthy but very emaciated.

4. The histological changes on which the phenomenon depends are a high degree of atrophy of the adipose and cutis, and simple atrophy and fatty degeneration of the primitive fasciculus. But also proliferative changes in the internal perimysium and connective tissue, as well as proliferation of nuclei in the sheaths of smaller vessels and thickening of the adventitia of larger vessels, play a part in it. On *post mortem* examinations, von Millbacher found the "tied fasciculi of Fraenkel" (*umschnürten Bündel*) abundant in muscles which during life had exhibited the phenomenon in a marked degree. Besides proliferation of the nuclei in the connective tissue and vascular sheaths, he always found, in the neighborhood of vessels with thickened walls, fasciculi bound around either partly or completely with connective tissue. Often, in fact, the proliferated connective tissue sheaths of both were directly proportioned to each other.

5. These anatomical changes impel us to rank this abnormal muscular irritability (which is obviously independent of nerve influence) with the excessive

irritability of muscles entirely withdrawn from nerve influence by cutting or degeneration of the nerves and involved in atrophic and interstitial proliferative changes. However, the two cases are essentially different. In motor paralysis, the nerves are degenerated down to their end-plates; here they are well preserved. In the former, the muscles are not subject to the will; here they are capable of function, even though they may be weak. There the reaction of muscles and nerves to the electric current changes with the succession of appearances which represent the reaction of degeneration,* and the entire muscle, or, at least, entire fasciculi of it, slowly respond without forming a contraction tumor; here only the part of the muscle which is directly affected undergoes a brief tetanus and sends out superficial waves, a thing that never occurs in the reaction of degeneration in excessively irritable muscles.

6. Though the analogy between the reaction of simple emaciated muscles and that of paralyzed muscles is not tenable, we do find an important relationship between the phenomenon under consideration and the physiological condition of exhausted or moribund muscle. Years ago Schiff noticed in the exhausted

* The reaction of degeneration, as described by Erb, consists in the loss of both galvanic and faradic irritability by the nerves, whilst the muscles lose only faradic irritability, but their galvanic irritability is always changed in quality and sometimes increased.—Tr.

or dying muscles of mammals precisely the same appearances which we observe in the emaciated muscles of consumptives. There can consequently be scarcely a doubt that in the atrophied muscles of consumptives we have to deal with a phenomenon of exhaustion and dissolution which occurs the more readily, the more atrophied the external tissues are.

Though this does not explain the intimate changes in the disease, we are justified by this physiological parallel, as well as by clinical observation, in concluding that this idio-muscular contraction has nothing to do with tuberculosis itself; that it is merely a phenomenon connected with emaciation and going hand in hand with the general waste of the tissues; and that consequently it has no diagnostic significance.

CHAPTER IV.

VITAL CAPACITY OF THE LUNGS—BODY WEIGHT.

I will next briefly refer to two appliances which are valuable for diagnosis, for the continued study of a case, and for determining the line of treatment, and which I think have not been sufficiently appreciated by physicians, namely, the spirometer and the scales.

In speaking of the *spirometer* I shall not consider the physiological side of the subject of lung capacity but shall limit myself to some practical questions.

Spirometry is seldom used by physicians, partly because it is thought that its results depend too much on the patient's skill and practice to have exact and constant value, and partly because we have no absolute standard of vital capacity in health. These views, however, are not verified in practice. There are of course many clumsy men, especially in the lower walks of life, who are unsuited for examinations in which they themselves must co-operate with the physician. But their number is very much reduced if pains are taken to instruct them. In my hospital wards we have by patience and practice generally succeeded in making spirometric measurements; though we also noted that clumsiness in this matter prevails more among women than among men.

As regards the second objection, namely the impossibility of assigning an absolute value to vital

capacity in health, it is true that such an impossibility exists because the amount of vital capacity depends on very different factors. Among these, stature is the most important inasmuch as a constant proportion exists between vital capacity and size of body, though different in the two sexes. The other factors, for example, circumference of chest, length of flanks, weight, age, trades, etc., do not affect vital capacity to such an extent as stature. Accidental factors, such as a full stomach, intestinal flatus, position of body, etc., can always be removed. Guided by four years' experience, I advise that only the relation between the volume of expired air and the stature should be taken as a standard in estimating vital capacity. Both can be easily ascertained and the proportion between them needs only a moment's calculation. Hutchinson, the inventor of the spirometer, and Winternich calculated the vital capacity in units of linear measurement, that is in inches and centimeters.

I have endeavored to establish a sort of boundary line between normal and sub-normal vital capacity, and I have found that the minimum proportion in health is one to twenty for men (*i. e.* one centimeter of height to twenty cubic centimeters of vital capacity) and one to seventeen for women.* These limits have of course only an approximate value, but that does not

* Denoting height in inches and capacity in cubic inches, the proportion will be for men 1 to 3, and for women 1 to 2.6 —Tr.

much matter in practice because in the pathological conditions which come before us we have usually to deal with wide variations. Furthermore, the chief value of spirometry does not consist in absolutely determining the vital capacity but rather in noting the variations of vital capacity in the same individual during a lengthened period of time. Consequently, the procedure is less valuable for primary diagnosis than for noting changes in the respiratory function during a course of observation and treatment.

The pathological conditions of the respiratory organs which diminish vital capacity are very numerous. They include all acute and chronic affections of the lungs, pleuræ, heart and thorax, and affections of the abdominal viscera which narrow the thoracic space. Hence spirometry serves only to corroborate the results of other methods of examination. Among the changes which most influence vital capacity I may name (in addition to pulmonary tuberculosis) adhesions of the pleuræ following pleuritis, adhesion and lifting of the diaphragm, pulmonary emphysema, cirrhosis of the lungs and bronchitis.

We may then say in general: When the proportion of stature to vital capacity falls below one to twenty in a man or one to seventeen in a woman, we may infer a considerable disturbance of the respiratory organs, the nature of which is to be determined by other methods; if, however, we should find a proportion of, say, one to twenty-five in a man or one to

twenty-two in a woman, such a disturbance would be *a priori* improbable.

The *absolute* value of these data may be illustrated by an example. An unusually tall and slender youth of twenty-five years, the son of a father who had died of phthisis, was brought to me by his anxious mother to learn whether his emaciation, pallor and sickly appearance were due to any pulmonary trouble. The physical examination resulted negatively. Still, isolated rales in the upper lobes in connection with the anæmia, the "paralytic thorax," the poorly developed muscles, the cardiac palpitation, and the tendency to perspire at any vigorous muscular effort, made the case suspicious as one of quickly developing tuberculosis. The spirometric examination gave for a height of 186 cm. (74 inches) a vital capacity of 5,000 ccm. (305 cubic inches), or a proportion of 1 to 27 (1 to 4.1 in inches and cubic inches). This rendered the exclusion of tuberculosis more certain and gave definiteness to the therapeutic indications. Three months later the vital capacity was found to be the same, and the measures adopted in the interim (shower-baths, sea-baths, mountain climbing and bodily exercise) had produced a gratifying effect on the general nutrition, the muscular strength, the color of the skin and mucous membrane, and also on the cardiac palpitation.

A contrast to the above is furnished in the following case. A young man belonging to an apparently

healthy family had not long ago an attack of hemoptysis, and since then he has had a dry cough without expectoration. Otherwise he seems not much affected. Physical examination showed a scarcely appreciable difference in the apices and at the same place isolated rales and prolonged respiration. The pleuræ were free, and the position of the diaphragm and the movement of the edges of the lungs normal. The spirometer gave for a stature of 175 cm. (or 68 inches), a constant vital capacity of 3,200 ccm. (or 195 cubic inches), or a proportion of 1 to 18 (1 to 2.8). This made the diagnosis of beginning tuberculosis pretty certain. A few months later we found tubercle bacilli in his sputum.

The *relative* value of spirometry is shown best in cases where definite changes are noted in the respiratory apparatus and where repeated tests are made during a long course of observation.

If even a slight increase in vital capacity appear during a course of climatic or other treatment, it is valuable for prognosis and will be usually found to correspond with improvement in other directions. But a rapid or slow decrease is an ominous confirmation of other unfavorable appearances. I will also cite a case in illustration.

In a young woman, twenty-eight years of age, with an inherited weak constitution (tuberculosis was shown only in her maternal uncles and aunts), an undoubted tuberculosis of the apices, bacilli in the sputum, etc.,

the spirometric test gave a constant vital capacity of 2600 ccm. (128 cu. in.) for a height of 160 cm. (63 inches), that is a proportion of 1 to 15.6 (1 to 2.5). She passed the winter at Meran, where she was almost entirely free from fever, and where she took regular exercise in climbing. Her appetite improved; she gained 6 kgrms. (13 lbs.) in weight, and the next year possessed a constant vital capacity of 2700 ccm. (164 cu. in.), that is a proportion of 1 to 17 (1 to 2.6). Four years have since passed and she is still healthy, the dullness over the apices has almost completely disappeared, and bacilli are no longer found in the sputum.

Of course I could furnish a far greater number of cases which contrast with this favorable one and in which the vital capacity steadily decreased. The decrease may be very great, partly through progressive infiltration, partly through fever, muscular weakness, etc. Often in advanced cases we do not get a higher proportion than 1 to 8 (or 1 to 1.2). Nevertheless, where vital capacity rapidly and notably diminishes, we should not infer that the tuberculous process is spreading unless the physical examination also indicates it, and unless we can also exclude diffuse bronchitis, pleuritis, high fever, etc.

The *scales* are another apparatus valuable as an aid in diagnosis and prognosis. They have been long used in hospitals and health resorts for diseases of the chest, but seem to be but little employed in private

practice. The knowledge of the patient's weight has a relative, not an absolute value. Abstracting from the extreme loss of weight which occurs in the last stage of consumption, we would be still less justified in making our diagnosis merely from the fact that a patient weighs 50 or 70 kilograms (110 or 154 lbs.) than we would be from a knowledge of his absolute vital capacity. In the latter case we have at least the stature with which to compare the volume of expired air. The size of the body cannot, however, serve as a standard by which to judge whether the average weight is normal or abnormal, for there are people who have diseased chests and whose weight is considerable on account of their large bones, and, on the other hand, there are slender delicate persons who are entirely healthy in spite of light weight. Hence, weight has no absolute worth for diagnosing or excluding tuberculosis, except in so far as its variations upwards or downwards may speak for or against the supposition of that disease.

But weight becomes an useful guide when it is tested at regular intervals in a patient, as is done in sanitariums for chest diseases and in many hospitals. After the diagnosis of tuberculosis has been settled, the scales will inform us whether the process is advancing or receding, whether fever is present or not, and whether the assimilation of food is sufficient.

Even the maintenance of a steady weight, after having recouped a previous loss, is a favorable sign as

it probably speaks against a progressive tendency of the disease. Steady loss of weight is always a bad omen, and worse in proportion to its rapidity, for it shows that the general economy is breaking down under the influence of the fever. On the contrary a steady even though slow increase, especially in connection with other local and general signs of improvement, indicates a disappearance of the fever and a better condition of the appetite and assimilation. I need scarcely say that no physician will be misled by an increase of weight produced by œdema of the limbs. Thus, if the patient were in the country or at a health resort, the scales would keep the family physician informed as to the course of events in the same way that the spirometer would. Every decrease of weight below the equilibrium warns the patient that something is wrong and causes him to seek the advice of his physician. On the other hand, every increase in weight tells him that his condition is satisfactory, increases his confidence in his treatment and strengthens his fidelity in following it. Tabulated or graphic statements of the regular weighings are of great interest to the physician and enable him and the relatives, even when the patient is at a distance, to form a pretty correct judgment as to the course of the treatment. The record of weighings sent by the patient is a sort of supervising report on the issue of the therapeutic efforts.

The above points are all important, and deserve

the notice and study of the readers. Every physician knows how helpful, nay necessary, an exact diagnosis is in the beginning of tuberculosis. Here as elsewhere is true that memorable saying of Van Swieten: "Qui bene diagnoscit, bene medebitur."*

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*A correct diagnosis is half the cure. Literally, he who diagnoses correctly will treat well.—Tr.

PART THIRD.

THE THERAPEUTICS OF PULMONARY TUBERCULOSIS

CHAPTER I.

PROPHYLACTIC TREATMENT — HYGIENE — CHOICE OF EMPLOYMENT—PRECAUTIONS AGAINST CONTAGION—HYDROTHERAPY.

The discovery of the bacilli as the cause of tuberculosis has given us a new standpoint for its treatment, but so far has had no other important result. The first thought was of course to direct all therapeutic efforts against them, and the hope was expressed by many that some remedy might be discovered which would, without injuring the body, limit or destroy their growth or vitality. This hope of sanguine investigators has not yet been fulfilled, and there is but little prospect that it will ever be realized. However, modern medicine teaches more clearly than ever before that one should not play the prophet, and consequently I shall not disturb with doubts the hopes of those who look for the ultimate extinction of tuberculosis in the human race. Though we have no specific remedy for the disease, we can still do much

for its treatment, especially in the domain of dietetics, by an intelligent and well-planned manner of living adapted to the needs of the individual constitution.

I will take as the starting point of my remarks an expression of Graves, cited by Hermann Weber: "It would be a great help if we knew how to make a person consumptive, for by pursuing the opposite course we would be able to prevent phthisis." The desire expressed in these words has been fulfilled by modern research, the real cause (*materia peccans*) has been laid bare, and the conditions which favor its acquisition have been recognized. An abundance of facts and observations have been accumulated concerning the causes which chiefly favor the development of the disease, whether an hereditary tendency be present or not. I have already described these causes in Part First, and shall now limit myself to designating the points of view to which their consideration necessarily gives rise. I shall begin with the observations made there, concerning the development of tuberculosis in healthy inmates of prisons, convents and hospitals. The Sisters of Charity, whom we see all day long in our hospital wards going about their blessed work with utmost zeal and devoted self-sacrifice, show us very clearly how tuberculosis is acquired and what injurious influences favor its development. The continual breathing of confined air, little or no outdoor movement, much work, monotonous diet, little recreation and much night-watching are the principal causes. Ex-

perience also teaches us that mental agitation, spiritual struggles, cares, etc., contribute to diminish the body's power of resistance to the disease.

How does the disease develop? What precursory symptoms herald it? Here, as among the prisoners described by Baer, the beginnings are scarcely noticeable. We find rather a picture of anæmia with muscular weakness and anorexia. Cough and impaired respiration are not necessarily present. Yet the physical examination will show infiltration. Baer found such lingering infiltrations, followed by rapid decay, in prisoners subjected for a long time to unaccustomed hard labor or much penal dieting, or to the influence of great grief or deep sorrow.

In marking out a line of prophylactic treatment, we must bear in mind those conditions which favor the development of the disease. They show us clearly what must be avoided. Instead of sitting in a room, there must be outdoor movement; instead of straining and incessant action in a confined place, there must be regular but not excessive outdoor muscular work, with intervals of rest; instead of limited diet, there must be good and varied food corresponding to the work and consisting of albumenoids, fats, and carbohydrates; there must be light stimulating drinks, at least seven hours of sleep, and frequent visits to the country with complete freedom from all duties. Persons whose means permit it may extend this antituberculous manner of living by trips to the mountains

or on the ocean where the air is absolutely pure and free from dust and bacilli, or by taking such forms of exercise as will necessitate deep inspiration in a pure atmosphere, such as mountain climbing, rowing, trapeze practice, etc. *The essential thing is the deep inspiration of pure air conjoined with outdoor muscular exercise.* The Pommeranian laborers and drivers have only plain food, hard work and little sleep all through the summer; but they do not become consumptive. On the contrary, they thrive remarkably well in the fresh air, for they always enjoy enviable appetites, tireless strength, sound sleep and the best of spirits. Consequently, to prevent phthisis, it is necessary to avoid close and impure air and to take sufficient outdoor exercise, moving around or working.

The question presents itself, why are not prisoners put at outdoor work? Why are they packed together in close working rooms and impure atmospheres? It has been found practicable to keep the insane at rural employments and to watch over them; why should it not be possible in the case of prisoners? Why not allow prisoners to indulge in athletic and other physical exercise? Surely it is not the intention of the law that the criminal, whose removal from society is necessary for its safety, shall become sick and die! The penal code aims to punish and improve, not to make sick and slay. Yet, as things now are and always have been, a sentence of five, ten or twenty years' confinement, or for life, means a sentence to a

very great risk of consumption. Certainly the hygiene of prisons has been immeasurably improved, and in consequence those terrible epidemics of typhus, scorbutus, dysentery, etc., which once decimated them have disappeared. Tuberculosis alone remains and its mortality statistics are enormous—three or four times more than among the general population.

During the years from 1825 to 1842, twelve out of every thousand prisoners in the great English penitentiary at Millbank died of phthisis, while during the same years the mortality in the city from that cause was only 4.37 per thousand. Two hundred and five deaths occurred in the penitentiary during those years and eighty of them were due to phthisis. Besides that, ninety persons were liberated on account of advanced tuberculosis. In the Prussian prisons, the proportion is about the same. At Plötzensee,* from 1873 to 1882, one hundred and thirty-nine prisoners died of whom ninety-one or 65.4 per cent. died from phthisis, and besides, forty consumptives were liberated. Almost all prisons give a like proportion.† Such a mortality from consumption, in spite of relatively good hygienic arrangements and a relatively small total mortality, is something awful. Yet these figures are not high enough, for *post mortem* examinations of convicts who had died from other diseases showed in

* Plötzensee is a penitentiary near Berlin.—Tr.

† See Appendix for statistics of American penitentiaries. —Tr.

most cases a more or less developed tuberculosis. Baer states as the result of his experience as prison physician that *it is an exception to find in the post mortem of prisoners the lungs free from tuberculosis.*

In estimating the danger of consumption in prisons, there is another thing to be noted. The highest mortality from tuberculosis is not found in collective prisons and houses of correction, where the deteriorated atmosphere of working rooms and dormitories is breathed by the prisoners in common, but in prisons conducted on the cellular system. And this is so notwithstanding that under the latter system the healthy prisoners are entirely separated from the diseased ones, that the volume of air furnished the prisoners is much larger than in the collective system, and that the atmosphere is better and the floors and walls much cleaner. Hence, the ubiquitous nature of the tubercle bacilli being understood, the infection depends essentially on the deprivation of outside air and outdoor work. That the diet is monotonous and often innutritious cannot be denied; and psychical causes also, such as *ennui*, lonesomeness, repentance, longing after freedom, etc., must not be undervalued. I believe that with a plentiful supply of air and suitable outdoor work in moderation not only the appetite and sleep would be better, but the disturbed and depressed spirits would be notably improved. These considerations deserve the attention of lawmakers. The causes of the disease are clear, and the

evil cannot be gotten rid of without changing the manner of working and increasing the supply of fresh air. After the immense advances made in prison hygiene during the last fifty years, no one will deny the possibility of changing the existing rules in the direction indicated.

What has been said of the prison applies, *mutatis mutandis*, to all trades and avocations which bring together a number of persons in crowded, unhealthy rooms and deprive them of fresh air and freedom. Statistics of the French and English armies show that the ratio of mortality from consumption quickly decreases at the beginning of wars or military manœuvres, and at once increases on return of the soldiers to the barrack life of peace. The German army owes its small mortality from this cause, not only to the careful selection of recruits and the excellent sanitary condition of the barracks, but especially to the regular summer and winter marches and other outdoor physical exercises.

The case of cloister-like seminaries, orphanages and educational institutions is similar. The more the free exercise of youth is limited in such institutions, the more frequent is tuberculosis, as Fourcault has shown by a number of most convincing examples. A state supervision of hygiene in seminaries and similar institutions, especially in girls' boarding schools, seems to be urgently necessary. The youth of Germany enjoy too little freedom and outdoor exercise. At

school, especially in the intermediate schools, an excessive and pedantic care for order and discipline limits the enjoyment of fresh air in the intervals between the classes. At home, when supper is over, the pupils must at once set about preparing their lessons for the morrow. There are, of course, gifted pupils who can prepare their lessons in an hour and then have time for play, walking, music, etc.; but the average pupil if industrious must devote the most of his free time after dinner or supper to study, so that he seldom or not at all gets out of doors. How many children perish every year on account of this unnatural way of living! Contemplate the pale, thin boys and girls as, tired and exhausted, they leave the school at the close of their studies. Compare them, relaxed and over-worked, with English boys and girls whose every minute of free time, in or out of school, is given up to ball playing, climbing, wrestling, rowing, etc. What a difference in the color of the skin, the bright glances, the active movements! I know of prominent intermediate schools where the forenoon recess consists of only seven or eight minutes out of doors, and even then the pupils are not allowed to romp or play, but must walk about sedately and converse.

Dr. Hermann Weber, of London, one of the most prominent and most esteemed German physicians in foreign countries, and one well acquainted with English manners, pointed out the difference in physical

training among pupils in Germany and England in a paper read before the Third Congress of General Medicine at Berlin. In a series of essays, lately published, on the Hygiene and Climatic Treatment of Phthisis, he has again urgently insisted on the necessity of careful attention to the physical training and outdoor exercises of growing youth. Medical attention in Germany has hitherto been taken up with the hygiene of schools in relation to myopia. It is indeed time that it should be directed to a sufficiency of recreation, the choice and supervision of games, the estimation of each pupil's vital capacity, a systematic noting of his weight in relation to size, and finally to his muscular power. Such regular investigations (which ought to be made every three months) would furnish valuable information for the training of youth. The school would become a channel of instruction for parents regarding the improvement of their children's constitutions. A half day every quarter devoted to such purposes would make no great inroad in the school work but would be invaluable in its results for the physical development of the pupils, especially of any with weak constitutions or with a direct disposition to tuberculosis. The physical development of children belonging to these two classes should receive the unremitting attention of the family physician. Every catarrh, every swollen gland, every skin affection, every trouble, though apparently unimportant and hardly worthy of notice in a child free from an heredit-

ary disposition, must receive careful attention and treatment. Even if no such disturbances occur, the physical training of children exposed by inheritance or otherwise to tuberculosis must be constantly supervised. We should insist on the boy or girl spending at least several hours every day out of doors. We should mark out the regular exercises, which should include ball playing, turning, skating, rowing, bicycling, hill-climbing, etc. All this applies not merely to vacations, when of course it is understood, but to the school term when every day is spent in the impure air of the school or bent over books at home or in class.

The selection of an employment suited to persons disposed to tuberculosis ought to be left to the physician. Unfortunately his opinion is not often asked or followed. In general, one may say that such persons should avoid employments which do not allow muscular activity and which require them to stay in close rooms. Pursuits which keep them continually in the open air and allow abundant activity to the muscular and respiratory systems should be chosen. The following may be named as being least dangerous: Military service, farming, gardening and sea-faring. Of the learned professions, theology and medicine are recommended, the former because of the country pastorates which it offers, and the latter because the whole world is open to the doctor. In the case of girls, sewing and embroidery should be forbidden,

and bodily exercise, walking, mountain-climbing, etc., recommended.

These are not theoretical deductions, but they are the lessons of experience. I might cite cases from my own experience which would show the eminent importance of a right choice of employment for persons predisposed to disease, but I know of no case so striking as one mentioned by Weber, and which I reproduce here, presuming on his friendly permission.

A teacher of languages and his wife, both sprung from tuberculous families, died of phthisis under Weber's treatment, one shortly after the other. Of their seven children, one had died previously of tubercular *meningitis basilaris*. The other six, ranging in age from one to twelve years, were healthy except the youngest boy, who was somewhat rachitic. Still, the inherited constitutional vice of these poor orphans was as bad as could be imagined. After the death of the parents, all the children were taken by well-to-do relatives who resided in a hilly district of Silesia, and there they received a rational physical training such as I have indicated above. What was the consequence?

The eldest son remained healthy as long as he devoted himself to an open air life. But in his twenty-third year he plunged into the study of philology. He worked at it day and night, wholly gave up taking physical exercise, and spent most of his mealtimes in his study. In eighteen months he died of "galloping"

consumption. The second son became a farmer and enjoyed the best of health until his twenty-ninth year. He then found that his business was not profitable enough, and began to work in a mercantile house, where he was shut up most of the day in a poorly ventilated office. Besides, he studied industriously at home. After two years of this intense "city work," he began to suffer from repeated hemoptyses and died after hardly two years' duration of the disease. The third son became a cavalry man, leads an active rational life, and is a strong and fine-looking man. The fourth child, at that time a girl of five years, is now the wife of a country clergyman in a healthy part of Silesia. She has no children and is perfectly healthy. The next son, who was rachitic in childhood, has become a strong man. He is a farmer in Manitoba, America, and the sixth child (the youngest girl), who lives with him, is also strong and healthy.

This very instructive history shows how beneficial open air life is even in the presence of a pronounced family tendency to consumption, and how sternly in the same condition, the violation of hygienic laws is avenged. The history covers a period of thirty years, but we cannot say that it has reached its end. Unfavorable circumstances, care, troubles, especially a sudden change from an open air life to an indoor one, may cause the latent tuberculosis to develop or the existing disposition to yield to direct infection. Such cases occur often enough in practice. Persons die of

quick consumption in their fiftieth or sixtieth year, although they have previously been always healthy or at most had suffered from "catarrh" in their youth or later years. The *post mortem* shows in the lungs of such patients old remains of a healed tuberculosis in the form of crooked scars at the apices which enclose cheesy or calcareous lumps or small cavities or are entirely indurated. That these scars are really remains of a healed tuberculosis is undeniable, for industrious investigation has discovered isolated tubercle bacilli in them or in the old, pigmented, cheesy-hard bronchial glands. Such cases account for tuberculous diseases in children which seemed inexplicable because the parents were always supposed to be perfectly healthy. The early tuberculosis of the latter was either entirely overlooked or else was euphemistically described to the patient and his family as chronic catarrh, slight bronchitis, etc. If one has an opportunity to carefully examine these cases he may be able, even after the lapse of years, to diagnose the healed phthisis with tolerable certainty, on account of the flattened apices and the slight difference in the intensity of the percussion note and in the quality of the respiratory sound. That is a very important point for a doctor engaged in life insurance examinations.

We now approach a part of the prophylactic treatment, the importance of which is perhaps greater or mayhap less than would be on the moment imagined. I mean *the avoidance of tuberculous contagion.*

It necessarily follows from Koch's doctrine that tuberculosis is contagious, and the preventive treatment must be regulated from the same standpoint. Clinical experience, however, has not verified an actual contagion from man to man, and the results of the general congresses organized in France, England and Germany have not favored, so far as can be seen, the view of a direct contagion.

Notwithstanding that, it is advisable, when one parent is phthisical, to deal with the matter plainly and to insist that the patient shall not kiss spouse or children, that the sputa shall not be cast on the carpets but shall be suitably disposed of and disinfected, that the soiled handkerchiefs shall be separately disinfected, and that the room with all its carpets, curtains and furniture shall be frequently cleaned and always kept ventilated. If at all possible the sick person should occupy a separate room or certainly at least a separate bed. Such precautions, I admit, are onerous, distasteful, and in a manner penal. They create in the healthy members of the family an aversion to the patient, a dread of being infected, and are so opposed to familiar feelings and customs that they cannot be successfully enforced in practice. Still, if the father and mother are at all reasonable, these stringent precautions will benefit the children. Children seem to become infected, especially in the first years of life, by frequent kisses of a consumptive mother, or by the contamination of their food with her saliva, or by the air

of her sleeping room. The physician must appeal to her maternal devotion and, by placing clearly before her eyes the danger to her child, make her realize that she holds its life and health in her hands. The maternal heart will unconsciously concentrate all its tenderness on the babe's well-being. Of course a tuberculous mother should not nurse her babe, and great care should be taken to avoid tuberculosis in the selection of a wet-nurse for it. So far, bacilli have not been found in the milk of consumptive women, but it is only a question of time until they will be demonstrated, for the infectiousness of milk from tuberculous cows, even where the udders are not tuberculous, has been fully established by experiment.

The danger of infection by milk of tuberculous cows (especially if the udders should be ulcerated) is not absolutely very great, for it is calculated that at most only two per cent. of cattle are tuberculous. However, when we reflect that the consumer has usually no control over the source of the milk, that he seldom knows the condition of the herd that supplies it, or whether it is the product of one sick cow or a part of the mixed milk of the entire herd, the danger is still considerable. Hence, before using, *all milk should be sterilized by boiling*. Five minutes' boiling will be sufficient, and the mistress of the house should herself attend to it. As to infection from using the meat of diseased cattle, the strict supervision of the slaughter-houses guards against that. Butter and

cheese made from the milk of tuberculous cows may also be infectious, but the danger from their use by a growing child with good digestion is much less than the danger to a babe from use of the milk. Besides, they are articles that may easily be dispensed with, if any anxiety is felt.

The precautions against infection to be adopted by healthy persons (Sisters, nurses, etc.) in charge of the sick will be apparent from all that has been said. Plenty of fresh air and outdoor exercise should intervene between the periods of nursing. Ample sleep is required. Delay in the sick-room should be as brief as possible, and there should be an adjoining room, well ventilated and with open windows, for the use of the attendants. The linen, and especially the handkerchiefs of the sick, should be placed after use in a five-per-cent. solution of carbolic acid, and afterwards washed separately from other soiled clothes. The floors of the sick-room should be often wiped with moist corrosive sublimate wool; the furniture and cushions should be taken out of doors once a week and be beaten and brushed; and the doors, walls, and carpets should be rubbed with bread. The dishes and vessels used by the patient in eating or drinking should also be kept separate. These precautions will enable nurses and relatives in attendance on tuberculous patients to avoid personal risk of contagion without in any way detracting from the carefulness of their attendance. The chief thing is to have regular and

sufficient fresh air and active outdoor exercise. Patients are selfish and apt to resent the absence of the attendant, so that the physician may have to exercise his authority in the matter. The maintenance of the nurse's health and ability to work is for the ultimate advantage of the patient. The doctor should determine how many hours each day the wife or daughter of the patient should take air, for they will usually be averse to do of their own accord anything that might savor of neglect or indifference. It is his duty to think not only of the patient but also of the attendants whose unceasing work often injures themselves without being of any real benefit to the patient. Indeed, the care for the healthy should often take precedence of that for the sick.

Over the male and female religious orders who take care of the sick, and their work, we, as doctors, unfortunately have no influence. They are entirely regulated by the rules of the order and the commands of the superior, and they are often worked beyond their strength by the demands made on them by suffering humanity. Many a blooming life would be preserved, many an individual maintained in health and well-doing, and certainly sickness and death would be diminished by one half, if medical warnings were heeded and if considerations of health were more regarded than the rules of the order. Hundreds of these admirable and devoted beings perish every year, without benefit to humanity, crushed under the wheels of an inflexi-

ble machinery. Say that the supply of nurses is not adequate to the constantly increasing demands and that this leads to overwork. I reply that each individual's capacity for work has its limits, and that these limits are usually exceeded by the superior from the worthy motive of extending to as many suffering people as possible the benefits of a well regulated system of nursing. The remedy should be placed entirely in the hands of the physician. It consists in care for the maintenance of health in the nurses, and that will result in the greater benefit of the patients. No one will consider that the merit of those noble men and women who voluntarily resign the pleasures of earth to devote themselves to their suffering fellow-beings is in the least diminished by attention to their own health and strength. On the contrary, every intelligent man will praise a religious order which seeks and obeys competent advice for the maintenance of the health of its members and so preserves their lives and usefulness.

I now proceed to some other points of prophylaxis, which I judge especially important for the protection of persons who are disposed or at least exposed to. tuberculosis. I have already said that the chief thing necessary is an abundant inspiration (deepened by outdoor muscular action) of an atmosphere as free as possible from dust and bacilli. This is best attained by a sojourn in the mountains and by mountain-climbing, or on the ocean or sea coast with rowing and

other exercises. Few persons, however, can afford such changes of locality which may need to be prolonged for months, or perhaps even for years. An excellent substitute for persons who can afford it is a visit to the country, more or less distant from the great cities, where there will be opportunity for young men to hunt, row, ride bicycles, and practice athletic exercises, and for young women to indulge in gymnastics, ball, nine-pins, and running games. Every minute of favorable weather should be passed out of doors.

What are called *Vacation Colonies* have been established by humane societies and individuals so that poor children, especially such as are scrofulous or anæmic, or have an inherited tendency to disease, may enjoy the psychic and hygienic benefits of a country sojourn. These institutions are eminently practical and deserve to be introduced as widely as possible. The influence of such a visit on the health of weak children growing up in poverty, in narrow damp houses and with scant food, is most excellent, and many a sinking constitution is strengthened and directed into normal paths. Physicians should strive in their respective circles of practice to interest as many as possible in such noble works of humanity. Children's Homes or Asylums erected on the sea-side attain the same end and are of utmost benefit for scrofulous and weakly constitutions. But they can only benefit a limited number of individuals, while the

Vacation Colonies can reach a far greater number. Every city and town could organize them, and in course of time we might expect that hundreds of thousands of poor little ones would every year enjoy their benefits.

For grown up youth whose station of life is established, such as clerks, mechanics and employes generally, it is of course more difficult to supply the indispensable fresh air and outdoor exercise, because almost all their time is claimed by their work. Such young people ought to join athletic societies, bicycle clubs, etc., which will furnish both fresh air and exercise, and drill and strengthen the entire respiratory system. That is, at any rate, incomparably better than to seek the bar-room at the close of work and to spend hours in a hot and smoky atmosphere. The sputa of bar-room loungers (which Panizza and I examined largely) showed by the abundance of cells, coal particles and myelin that the respiratory organs are subjected in such places to a continuous even if slight irritation. Such a condition, joined to incomplete expansion of the lungs, favors the disposition to take up bacilli. On the contrary, gymnastic exercises (even in doors, provided the dust is kept down with tanbark) are a great benefit not only for the lungs and muscles of respiration but for all the functions of the body.

I cannot conclude this chapter on prophylaxis without referring to *hydrotherapy* which occupies a

very important position both for the prevention and for the cure of tuberculosis. Winternitz, to whom principally we owe scientific hydrotherapy, has published his experience relating to its use in this disease in a brief essay entitled "Studies of the Pathology and Hydrotherapy of Pulmonary Phthisis," which I strongly recommend to the reader's special study. My experience of the "hardening" method where there is an hereditary or acquired disposition agrees fully with his. Water at a suitable temperature is the best, simplest, most general, and most available agent for strengthening and "hardening" a weak body or one disposed to catarrhs and colds. Even a simple rubbing down of the entire body with a large moist cloth after getting up in the morning accustoms the skin to sudden cooling off. At first the cloth should be wrung out of lukewarm water and later on cold water may be used. The practice drills the vasomotor nerves of the peripheral arteries to prompt reaction. It acts centripetally as a thermic irritant to the central nervous system, stimulating and refreshing it, and indirectly on the innervation and function of the respiratory, circulatory and digestive systems. At first, water of about 24° R. (86° F.), is to be used, and the cloth should be well wrung out. On each succeeding morning the temperature of the water may be reduced $\frac{1}{2}$° R. ($1\frac{1}{8}$° F.). Winternitz does not concede that a milder effect is produced by the use of lukewarm water than by cold water. But in this

point my experience differs from his, possibly because his was derived from his water-cure establishment whilst mine is drawn chiefly from private practice. It is not at all a matter of indifference, I can say positively, whether one order a sensitive body rubbed with cloths wrung out of water at 12° R. (59° F.) or 24° R. (86° F.) temperature. Nervous and weak persons shrink from the cold applications and more readily submit to the warmer ones. It is very important that the friction should be brief, only a minute long, and that the cloth should be well wrung out (not "wringing wet" as in sponging or splashing). The aim is to produce a thermic and mechanical irritation of the superficial nerves and vessels, not to deprive the body of any considerable heat. This latter effect would be produced if the cloths were wet with cold water. To attain the desired end, very low temperatures are not needed and it is seldom necessary to go below 15° R. (66° F.).

In weak constitutions where appetite and assimilation are poor, I order from one-half to one pound of common salt and one-quarter liter (about 8 fl ℥) of caustic potash to be added to the water after the third week, so as to make an artificial salt bath.* This produces a more lively and lasting irritation of the

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*The German word is *Soole*. It means a saturated solution of salt, either from natural salt wells or made artificially. —Tr.

nerves, and, like mineral baths, improves the assimilation and nutrition. Such friction baths can be used in private practice everywhere and amongst the poorest people. They entail no expense and conflict with no duties, because they are taken immediately after arising, and the patient at once dresses and can go about his work. Unless the patient is very weak, I do not permit him to return to bed after the rubbing. It would be much better if he would at once take some outdoor exercise if the weather permit, and return after an hour to his breakfast. Very delicate persons, especially women, may be allowed a cup of warm tea or coffee before the friction bath, but all others should be fasting.

Patients who have no one to assist them with the rubbing may improve matters by using a large towel, or they may substitute a douche bath for the friction bath. This rain or douche bath is not so effective, because its stimulation is not so intense nor does it reach the entire surface. However, it is still an excellent method of hardening and invigorating the body.

Local frictions with cogniac in which salt has been dissolved are practiced in some sanitariums for chest diseases, but I do not attribute any particular effect to them. They miss the essential thing, that is, the sort of shock which is produced by wrapping the body in a wet cloth or sheet, and which innures the surface to sudden cold or dampness, produces prompt

action of the superficial vessels, and hardens the sensitive nerves of the skin.

Should a more thorough treatment be desirable, the patient may be sent to a water-cure establishment. This is necessary, however, only in persons who are deficient in will power. Most persons have firmness enough to persevere for months and years in such friction baths in their homes and with the help of their relatives or servants. This simple procedure, which may be varied in various ways, is one of the best within reach of the physician. It overcomes sensitiveness to changes of temperature, wind and dampness, and renders excessive clothing unnecessary. It overcomes constant slight perspiration, eternal nasal and bronchial catarrhs, rheumatic disposition, etc., and gives to the body a freshness and elasticity which can be procured in like degree only by mineral and sea baths. Its great advantage in being used at home, without expense and for months and years if needed, recommends it especially for people of moderate means.

The natural *mineral and sea baths* are, for those who can afford to go to them, an excellent agent for invigorating and strengthening the constitution and especially the sensitive respiratory surfaces. Their effect is due to various causes. In the sea baths, we have the chemical and thermic influences of the cold salt water, the mechanical irritation of the waves, the rapid movement of the air which is both free from dust and bacilli and rich in water and salt, and the

outdoor life. All these agencies affect the nervous system and through it all the organic functions, stimulating and invigorating all, and especially the appetite, assimilation and respiration. The lungs are impelled to deep inspiration, and their epithelial cells are strengthened by the quick motion and other favorable conditions of the air. The influence of mineral baths is analogous, especially those situated in mountain districts and, like Reichenhall and Kreuth,* rich in special curative agencies. In addition to the direct effects of such baths, the constant climbing of the hills in the pure air improves and deepens respiration. Systematic exercise in mountain climbing is one of the most beneficial practices for various chronic lung troubles, and its results are more effective and permanent the higher the level at which the patient resides, the purer and thinner the air, the lighter the atmospheric pressure and the less there is of rain, wind or fog.

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* Reichenhall and Kreuth are Bavarian Alpine resorts. The former has salt baths, "pine needle" baths, and an establishment for the whey treatment; the latter has sulphur baths.—Tr.

CHAPTER II.

DIRECT TREATMENT—HYGIENIC—CLIMATIC—DIETETIC—MEDICINAL.

All the important curative agencies mentioned in the preceding chapter are valuable not only for dealing with an inherited or acquired disposition to tuberculosis or scrofulosis, but also for the treatment of phthisis after it has become manifest and is proven by the presence of tubercle bacilli in the sputum. It is hardly necessary to repeat that the bacillus and its products and effects in the lungs must always occupy the foremost place in our studies. After it has once gained admission into the organism, the aim of all our treatment must be to combat and destroy it. Unfortunately there seems at present no prospect of accomplishing that aim in a visible time. Fraentzel, one of the most deserving and indefatigable investigators in this department of medicine, candidly admits that the result of all the experiments thus far made at the bedside and in the bacteriological laboratories is to show our inability to destroy bacilli or cocci domiciled in the pulmonary tissues by medicines whether administered in gaseous form or by atomization.

The best remedies, the remedies which medical experience shows to have produced the best results in the beginning of pulmonary tuberculosis, are still the physical ones—air, climate, exercise and water. Diet occupies only a secondary place.

Considering the importance of a definite and persevering treatment, all thought and effort should be directed to the selection of a proper course in the beginning of the disease, when hope of cure is still justifiable. Hereditary disposition, physical constitution of the patient and his entire family, age, sex, temperament, mental endowments and condition, tractableness and firmness, social rank and employment, financial circumstances—all these factors vary in different cases, and all affect the selection. But manifold as may be the differences in individual cases, the curative agencies already mentioned are of fundamental importance for all and should never be omitted.

The *fresh air treatment* occupies the first place. To a certain extent, it can be employed in all conditions of life, though of course modified according to circumstances, and consequently more or less limited in its effects. The simplest way is to keep a window open day and night, or to remain constantly out of doors, sitting or lying as preferred, and protected in bad weather by some simple shelter. In addition to this, the patient should practice deep inspiration, which may be done by climbing any hill or mountain near his house, or by regular gymnastic exercises, such as the use of bars, swinging ropes, etc. It is true that pulmonary hemorrhage may occur in such exercises, but I can scarcely believe that it is more frequent in consequence of a stronger expansion of the lungs than

otherwise. Mountain health resorts, which are accessible to persons of means, are also a form of the fresh air treatment. Such resorts for persons with pulmonary troubles are numerous and excellent. They are found in all high-lying districts from the Lower Alps to the elevated vallies of the Grissons, and all produce good results. Their success seems to depend not so much, if at all, on elevation of site as on the purity of air and the exercise of the lungs.

When I designate deep inspiration of pure mountain or sea air, accompanied by vigorous action of the respiratory and other muscles as the most essential part of treatment, I mean that bacilli and cocci do not thrive well in a constant current of pure air throughout the lungs, and that further settlements of them are prevented by the energetic action of the lungs and by the renewal of the air. High temperature and stationary condition of the air favor the bacilli, and hence good ventilation and low temperature must be beneficial to the patient. I will not decide whether other causes may not also contribute to the effect, as for example the improvement in the pulmonary circulation produced by the deep inspiration, and the freer expectoration of infectious matter resulting from the increased action of the lungs. Hence warm climates are, in my opinion, less beneficial than cool ones, provided, however, that other atmospheric conditions, such as stillness of the wind, sunshine, etc., are favorable, and that the patient can be constantly in the open

air. This opinion is confirmed by the excellent results obtained at Görbersdorf, Davos* and the elevated vallies of the Grissons, the Andes and the Cordilleras, where the patients can be much out of doors even in the winter. It is further confirmed by the immediate and rapid benefits derived from polar journeys and by the fact that tuberculosis is scarcely to be found among the peoples of Iceland, the Hebrides, the Faroe islands, the Shetland islands, and the northern districts of Norway.

The question as to the respective merits of public spas and private sanitariums is one of methods, not of principles. It is certain that the strict discipline of a sanitarium has the advantage of avoiding many dangers (such as pleasure parties, colds, indigestion, etc.), to which the guest at a watering place is exposed through ignorance, thoughtlessness or lack of self-control. There is besides a better guarantee for regularity of exercise and better precautions against taking cold. On the other hand, sensitive people find something abhorrent about sanitariums and feel much better in public watering places. If patients will patiently and

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* Görbersdorf is situated in Prussian Silesia, 1,840 feet above the sea. Dr. Hermann Brehmer (who is still living) established there a celebrated sanitarium for consumptives. It was the first erected at an elevation exempt from bacilli. Davos is in the canton of the Grissons in Switzerland, 5,940 feet above the sea. It is a favorite summer and winter resort for persons with pulmonary and nervous trouble.—Tr.

perseveringly follow the directions of their physician, they will obtain satisfactory results in the latter resorts. Of this I have had plenty of evidence among my patients at Reichenhall, Meran,* and other mountain resorts.

In the selection of a health resort, some authors attach great importance to the moisture of the atmosphere. But as far as actual experience goes, we must say that a dry climate with little rain and fog is generally more suitable for tuberculous persons than a moist one. As regards winds, provided the purity of the air is the same, the still atmosphere of high-lying, sunlit vallies is to be preferred, because there is far less danger of taking cold when out of doors or climbing the hillsides. The condition of the atmosphere as regards its supply of ozone, or its poverty in oxygen or (as in the upper Alps) its slight pressure, does not affect the therapeutic value of health resorts. The celebrated pine woods of many places, as for example in the Black Forest, to the aromatic exhalations of which a sterilizing influence on the diseased lung surfaces is ascribed, possess also the inestimable advantage of a dry, warm and wind protected situation, excellent for the prolonged enjoyment of the open air.

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*Meran is a winter resort situated in Southern Tyrol, about 1100 feet high. Fully 10,000 visitors go there each season (from September to June). The grape, whey and milk treatment are practiced and there are also pneumatic chambers. —Tr.

It is impossible to give in this short treatise all the details of climatic treatment. It would be well if physicians could personally visit and investigate the most important watering places and climatic resorts.

Finally, I take up that part of the treatment which enters the daily practice of the physician and which is consequently of great importance, no less to him than to his patient. It includes dietetics and the treatment of the fever which accompanies tuberculosis of the lungs. The treatment of other disturbances and complications is reserved for the third and last chapter.

The *diet* of tuberculous patients should be regulated according to the stage of the disease, the rapidity of its course, and the condition of the constitution. In the initial stage, when nutrition is as yet not essentially impaired, but the excitability of the heart and the tendency to congestions are considerable, it is advisable to decrease the albuminoids and to correspondingly increase the carbohydrates and fats. Vegetable diet has a slightly laxative effect and is beneficial in proportion to its amount of vegetable acid alkalies, as in fresh vegetables, fruits, etc. For this reason the grape cure and the whey cure conjoined with mountain air are excellent in the first stage. Raw and cooked fruits, cider and the like are also appropriate. Stimulating foods and drinks like tea, coffee and alcohol (which should be allowed only moderately and in the form of beer) are unsuitable on account of the

excessive irritability of the heart. The koumiss and kephir* treatment are good in the first stage if the patient can visit the steppe of Samara, or, at least, stay out of doors entirely. Cod-liver oil is also useful if the patient has good digestion.

In the later stages, when the constitution is undermined by the fever and the appetite has failed, it is difficult to adequately nourish the patient on account of the anorexia. If the fever is continuous, it must be met as will be hereafter explained. If it is slight and confined to certain hours, nutriment should be given as far as possible when it is not present, even though the patient should have to force himself to eat. I am sure that want of appetite and dyspepsia do not always depend on the fever, but that, like the night sweats, they may be purely a nervous disturbance and consequently accessible to direct treatment. Too much reliance should not be placed on medicines, though the simple and aromatic bitters with or without iron are often helpful. We should rather lay

* Kephir, or kefir, is a liquor made from the milk of a cow or mare by the addition of a special ferment. The ferment is contained in the grains of a plant which grows in the Caucasus. There are three grades of kefir, according to the time, one two or three days, taken in its preparation. The first or young kefir is used in pulmonary troubles. It has a laxative effect. The third or strong has a constipating effect and is used in abdominal disorders. In the beginning two or three glasses are to be taken daily and gradually increased to six or seven.—Tr.

stress on fresh air, especially mountain air, outdoor exercise, entire freedom from business cares, and a good, plentiful and varied diet. In choosing a health resort for consumptives, the kitchen is not the least important thing to be considered, for, even with slight appetite, better nutrition will be secured by abundance and variety of well-prepared food than by a scanty, monotonous and plain bill of fare.

Instead of relying upon the allurement of a well laden table, Debove has, in cases of anorexia, resorted to *compulsory over-feeding* either by the use of an œsophageal tube or by overcoming the patient's resistance. Our own experiments have shown that this plan of "sur-alimentation" produces brilliant but only temporary results in many cases. After several weeks, the excessive quantity of food, out of proportion to the gastric and intestinal juices, creates disturbances of digestion, flatulence, nausea, diarrhœa, etc. The treatment must be discontinued, and in many people its resumption at once brings on a recurrence of the disturbances especially where the assimilation is bad and the muscular action is insufficient.

The fattening treatment of Weir Mitchell is more sensible and more permanent in its results. The nutriment is, indeed, supplied during complete rest of the body, but assimilation is aided by judicious massage in lieu of voluntary muscular action. This passive condition produces in many cases a good effect upon the general economy, and not only results in an in-

crease of fat but also tones up in a surprising manner the general nervous and muscular system. I would recommend this treatment in cases of beginning or even advanced tuberculosis where there is little or no fever and where the constitution and appetite do not improve on account of the excessive nervous irritability. Such neurasthenic patients, especially of the gentle sex, often improve wonderfully under the enforced rest in spite of their tuberculosis.

As to drinks, *alcohol* has more and more during the last ten years acquired and deserved a prominent place in the treatment of tuberculosis. I do not recommend strong alcoholic drinks like wine and cogniac in the early stages of the disease, and in excitable constitutions, irritable heart, tendency to hemoptysis, etc. In such cases I allow only light beer in moderation and cider, or else I exclude all alcohol and permit only milk. The milk diet often produces excellent results when the stomach is good, but daily investigation must be made to forestall any gastric disturbance. In the later stages of the disease, alcohol is invaluable. It is used in almost all sanitariums and health resorts and in relatively large quantities, one to one and a half liters (about three pints) of wine and fifty to sixty grams (about two fluidounces) of cogniac each day. It invigorates the nervous system, gives a pleasant feeling of warmth and strength which is of value in the open air treatment especially during cool weather, increases energy

and endurance in exercising, produces quieter sleep and diminishes the night sweats. It produces these effects in various ways. It seems to me to act rather by stimulating the central nervous system and consequently the separate functions than by its inhibitory influence on assimilation (its "labor-saving effect") or by its action on the heart. That is shown by its effect on the psychical and intellectual functions and by the diminution of night sweats which are due to weakness of the nerve center of the sweat glands.

The quality of wine may be regulated by the patient's taste, but the fiery red wines, the Valletelino, Burgundian and red Hungarian wines suit better than light white wines. The kind and quantity of alcohol must be determined according to the individual case. Where the intestinal tract is very sensitive and there is a tendency to diarrhœa, with or without the presence of intestinal tuberculosis, an excellent evening drink is mulled wine, that is, red wine boiled with some cinnamon, sugar and cloves. The high temperature of the wine and the aromatic additions to it produce a very pleasant and anti-diarrhœic effect on the intestinal mucous membrane. The excellent "berry wine" (Beerenwein) or "forest wine" (Waldwein) from the factory of Fromm & Co., of Frankfort, is well adapted for making mulled wine, as its tannin is least brought out in that form. The "berry wine" is also highly recommended when slightly warmed, but not boiled. Delicate patients should not drink cold wines, and in

fact red wines do not taste well when cold. Cogniac should be given (one or two tablespoonfuls) chiefly in the evening and in the form of cold or hot grog. Many patients have an idiosyncrasy in regard to it and cannot drink it. It gives them palpitation of the heart or causes sleeplessness, etc. In such cases, arrac, rum, brandy or whiskey should be tried, or wine alone be used.

The fever, which unfortunately too often presents a most difficult problem, will be met in the beginning of the disease and in slight cases of relapse by the open air treatment and the dietetic regulations. Physicians at health resorts have frequent opportunity to witness the satisfactory antipyretic effects of the air treatment. Patients who at home kept their rooms for weeks at a time on account of the fever are soon freed from it at Reichenhall, Bozen,* Meran or San Remo. They quickly recover from its effect and not seldom escape it through an entire winter. Unfortunately this simple and pleasant therapy is not always sufficient, at least not in advanced cases. Then alcohol, which possesses a certain degree of antipyretic power, must be used. The antipyretics also (say what one will against them) are indispensable. The best of these are *antipyrine* and *antifebrine*. Though they may help but little in progressive cases with high

*Bozen is a town in Tyrol, noted as a winter resort. San Remo (made famous by the sickness of the ill-fated and noble Emperor Frederick) is situated on the Riviera of Genoa.—Tr.

fever, they are nevertheless indispensable on account of the sense of well-being which they produce. In moderate fever, they are often very satisfactory especially when long used, because patients are enabled to go out more into the open air, and the appetite and sleep improve. During the past few years I have preferred antifebrine. I give it in capsules, three or four times in the twenty-four hours in doses of 0.3 grams (4.6 grs.). When the fever occurs at a definite time, denoted by chill or shivering, we may attempt to abort it by giving at one dose 0.6 gram (9.2 grs.) two or three hours earlier and following that during the afternoon or night by two doses of 0.3 gram. Some sherry or marsala is recommended to be taken after the drug.

In many cases, it is best to check further development of the fever by treating the slight relapses as is done in intermittent cases. For this purpose the patient should carefully take his temperature regularly three or four times a day, and his weight should be ascertained every two or three days. In that way he will be able to correctly distinguish the fever attacks from simple discomforts and dyspeptic disturbances, and so use the antifebrine at the right time. In some the fever disappears only with a change of locality. Lukewarm or warm baths gradually cooled, with or without the addition of salt, and matutinal frictions with saline waters are also beneficial.

Creasote, first warmly advocated by Bouchard in 1877, and after him used with success by Reuss, Som-

merbrodt and Fraentzel, may be tried, especially in fresh cases with little or no fever. It is said to decrease cough, mucous secretion and fever, to increase appetite and weight, and to dissipate the phenomena of consolidation. Although many cases do not improve and many patients cannot endure the drug, still, according to those authors, the greater number are so much benefitted that a long-continued trial (from three months to a year) ought to be made in suitable cases and especially in persons whose employment or poverty will not permit recourse to the systematic open air treatment. On account of its disagreeable taste, the drug should be given in capsules, each containing (according to Sommerbrodt's prescription) 0.05 gram. (.75 gr.) creasote and 0.2 (3 grs.) tolu balsam. One or two capsules should be taken after each principal meal with a tablespoonful of water. After two months, it should be discontinued for a month. The entire course should last a year or longer. Bouchard's original prescription, adopted by Fraentzel, was:

℞ Creasote, 13.5 (ʒ iijss).
Sherry wine, ¾ litre (fl ʒ xxv).
Rectified spirits, 200.0 (ʒ vij).
Tincture of gentian, 30.0 (ʒ j).

M. Sig.—A tablespoonful to be taken in a glass of water two or three times a day.

Menthol has lately been recommended by A. and S. Rosenberg as an anti-parasitic remedy. It may be

taken internally six times a day in doses of one to one and a half grams (15.4 to 23 grs.) or by inhalation with Schreiber's apparatus, using fifteen or twenty drops of a twenty-per-cent. oily solution several times a day. Confirmation of its good results is still lacking.

Other antiseptic drugs have been tried in the form of *gaseous* or *atomized inhalation*, without, however, having produced any great results. Such are pine and beech tars, oil of mountain pine,* turpentine, oil of eucalyptus, etc. Though a directly curative effect has not been established for these inhalations, they are to be recommended for impregnating the atmosphere of the patient's room, especially of his sleeping room. They certainly have a real, though slight, antiseptic effect, and they reach the diseased parts of the lungs which harbor the bacilli and are exposed to the inroads of secondary colonies of cocci.

Arsenic is another drug recommended for tuberculosis. It was long used in France, England and Russia, and has lately been recommended on theoretical grounds by Dr. Hans Buchner. In practice, however, its claims are not confirmed, at least not as a specific. As a tonic for the nervous system, it seems

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*Oleum pini pumilionis, *Hæncke*, also called ol. templinum, or krummholzœl. It is distilled from the young branches of the mugho or mountain pine, from which "Hungarian balsam" is obtained. A refined form of it has been lately introduced, called pumiline.—Tr.

to have produced good results in many cases of torpid phthisis. I have no personal experience as to the results of carbonic acid inhalations or of Bergeon's *gas enemata* (prepared from carbon dioxide and hydrogen sulphide). I fancy that both methods, like so many other remedies for consumption, will be soon forgotten.

CHAPTER III.

SECONDARY TUBERCULOSIS—COMPLICATIONS —LARYNX—INTESTINES—ANAL FISTULÆ.

For the treatment of secondary tuberculosis and some complications which occur, I shall limit myself to what I have tested in my private practice, used in my clinics and recommended in my consultation practice.

Pulmonary hemorrhage is to be treated by laying from above downwards two ice bags on the anterior chest wall, including the apices, and by subcutaneous injection of a solution of sclerotic acid* (1.0 gram to 5.0 of distilled water, 15.4 grs. to 75 ♏), using a syringeful every hour. The place of the injection should be vigorously kneaded on account of the pain, or morphine may be injected. The solution of sclerotic acid is much better for subcutaneous injections than the solution of extract of ergot, which is more painful and may cause abscesses. I use the ergot for simultaneous internal use, and continue it beyond the duration of the hemorrhage in order to prevent relapses and to quiet the anxious spirits of the patient. For inhalations, liquor ferri sesquichlorati of the strength of 2.0 to 200. (♏ 32 to ℥ vi–vii) is used. It is not

* Sclerotic or sclerotinic acid is one of the most active constituents of ergot. It is a yellowish brown, tasteless, inodorous substance, with a slight acid reaction.—Tr.

supposed that the nebulized liquid reaches the bleeding spot in the pulmonary tissue and acts there as a styptic, but I explain its excellent results by a reflex contraction of the pulmonary vessels being caused by its marked astringent action on the mucous membrane of the upper air passages. Hence I only allow brief inhalations (one or two minutes), but repeated frequently, say every half hour. Morphine, either subcutaneously or internally, is strongly recommended to check the tendency to cough. Every cough temporarily alters the condition of the pulmonary circulation, and the patient dreads to cough lest it should bring on another hemorrhage. Between whiles, I require the patient to take deep breaths, which help remarkably to stop the bleeding. As soon as he has overcome his dread of danger from this deep inspiration, I instruct him to breathe strongly for a longer time. It not seldom happens that this procedure finally stops very obstinate and recurring hemorrhages.

Tuberculous ulcers of the *larynx*, *pharynx*, and *tongue* can rarely be cured. Chronic circumscribed laryngeal ulcers are the most tractable. The extensive ulcerations of the last stage make the prognosis positively bad and require only a palliative treatment with anæsthetics, especially cocaine and the bromide salts. In chronic laryngeal ulcerations of the early stage, I am opposed to strong remedies, especially to caustics like lunar caustic. I recommend instead mild antiseptics like boracic acid, potassium chlorate, creasote, lactic acid, or menthol.

In *intestinal tuberculosis*, the fight against the diarrhœa must be incessant. It and the accompanying discomfort in the abdomen are best controlled by opium; but for prolonged use the astringents, as tannic acid, nitrate of silver, and especially the milder astringents, colombo, rhatany and kino, or the anti-zymotics as naphthalin in keratin-coated pills* are preferable. Besides, warm spiced wines, especially mulled wine and the "berry-wine" described above, also rye flour soup (*roggenmehl suppe*) and oatmeal with dry or moist warm applications to the abdomen are recommended.

A very painful complication for the poor patient is the fatal *periproctitis* with formation of complete or incomplete anal fistulæ. There can be no question but that the inflammation of the peri-rectal connective tissue is due to the tuberculosis, especially to intestinal tuberculosis, for Schuchardt and Krause have found tubercle bacilli in the granulations of the fistula, and, even where bacilli were not found, the infectiousness of the granulation tissue was proved by successful inoculation in the anterior chamber of a rabbit's eye. On account of the rarity of tuberculous ulcers of the rectal mucous membrane, we must suppose that the

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* Keratinirten Pillen. The word refers to a special coating prepared from horn (*Κέρας*). It is not soluble in the acid juice of the stomach, and consequently enables the antiseptic to produce the desired effect in the intestines, in the alkaline juice of which it is soluble.—Tr.

periproctal connective tissues become infected from fæces containing bacilli through some small erosion or tear caused by long retention of the excrement. It is not possible at present to show that the periproctal bacillary process develops by way of the circulation, independently of changes in the rectal mucous membrane and analogous to the formation of fistulous ulcers in the scrofulous. It is much easier to suppose an infection direct from the contents of the rectal cavity—a view which Schuchardt advocates in his latest publications.

The success of the radical treatment of such fistulæ by incision, scraping or cautery is an additional and encouraging evidence of the curability of local tuberculosis. It condemns in a striking manner the old teaching that they should be left alone, because after the operation tuberculosis would at once develop in other organs. Tuberculous rectal fistulæ should be operated on radically and as early as possible. Tuberculosis will ensue in other parts just as seldom as it would after extirpation of tuberculous glands or after the operation for a knee-joint fungus in the early stages. I have had under observation for a long time several cases of chronic tuberculosis in which fistulæ were operated on some years ago without causing any development of the disease.

The treatment of pulmonary consumption covers a wide territory and I have been able to touch only some of its points. I would also gladly have dealt

with tuberculosis of the glands, serous membranes, brain, kidneys, skin, bones and joints, but I must have regard to the size of this book and will defer them to another occasion.

APPENDIX.

A. TUBERCULOSIS IN AMERICAN PRISONS.

In reply to requests, sometimes twice or thrice repeated, I received reports from the penitentiaries named below. The figures bear out the author's

	PENITENTIARIES.	Convicts Rec'd during Year.	Total Annual Population.	Daily Average.	Total No. of D'ths	D'ths from Phthisis.	Percentage.
	California:						
1	San Quentin (1888).	597	1817		32	15	46.8
2	Folsom (1888).	166	771	539	7	4	57.1
	Illinois:						
3	Joliet (1888).	647	1946	1321	45	35	77.7
4	Chester (1887).	373	1114	782	16	6	37.5
	" (1888).	344	1091	763	15	4	26.6
	Michigan:						
5	Jackson (1886).	293	1030	774	4	2	50.0
	Minnesota:						
6	Stillwater (1887).	208	595	398	4	2	50.0
	" (1888).	214	626	426	4	1	25.0
	Missouri:						
7	Jefferson City (1887).	686	2321		20	5	25.0
	" " (1888).	786	2399		19	2	10 5
	New York:						
8	Sing Sing (1887).	851	2383	1504	16	7	43.7
9	Auburn "	416	1500	1146	32	17	53.1
10	Clinton "	374	913	612	6	4	66.6
	Pennsylvania:						
11	Eastern (1887).	560	1691		27	21	77.7
12	Allegheny (1887).	262	968	686	8	4	50.0
	" (1888).	266	963	664	4	2	50.0
	Texas:						
13	Huntsville (1888).				28	9	32.1

startling statements. The percentage of deaths from phthisis in Chicago during 1887 was 8.77 of the total mortality. In many of the prisons it is from five to ten times higher. Naturally the criminal classes are more liable on account of their dissipated and vaga-

bond lives to consumption and other diseases. But, since tuberculosis is in all probability (nay, certainly) contagious, regard for the welfare of society if not for the health of the convicts should compel an earnest effort to diminish or destroy the danger from such prolific breeding places of the disease.

1. The physician at San Quentin says: "Whilst the climate of Folsom is warm and dry and preëminently suited to prolong the life of a consumptive, the moist climate of this place militates against and causes death in a short time. Another thing is that the men who are sent here from the southern country are mostly Mexicans and Indians and have the germs of scrofula and consumption in their blood on coming, which soon develops itself and through confinement they lose their hold on life and soon die." Besides the 15 prisoners who died of phthisis, 6 others died of scrofula.

2 One death at Folsom was from pneumonia, and there remained in the hospital at the time of the report 1 patient with phthisis.

3. In Joliet, there was 1 death by suicide and 1 from pneumonia. Among 1460 cases treated in the hospital during that year, 244 were for diseases of the respiratory system.

4. During 2 years, 9 cases of phthisis were treated in the Chester hospital. In 1887, there was also 1 death from acute tuberculosis, 1 by accident and 1 by suicide; in 1888, 3 from pneumonitis, 1 from tuberculosis of mesenteric glands, and 1 by suicide. These two cases of clear tuberculosis raise the percentage to 43 7 and 33.3: but for the sake of comparison I have considered only "phthisis" or "consumption" in the table. The physician says very properly, in reference to "the marked prevalence of tubercular disease in its varied forms," that "had the same people been left to the vices, excesses and deprivations characteristic of their lives on the

outside of prison, there is no doubt that fully twice as many would have died of this disease during the same period, as did here. The record shows many of them to have been men who had long been confined in prison; others were in an advanced stage of the disease when admitted and consequently could not have lived long, in or out of prison."

5. Of the prisoners received during the year at Jackson 276 were in good and 17 in poor health; 43 had lost one or other parent by consumption; 1 death was due to stabbing. The 2 who died of phthisis had been respectively 6 months and 25 years in prison.

6. Among the deaths at Stillwater in 1888, 1 was due to accident, 1 to suicide, and 1 to scrofula. All the patients who died from disease were diseased when they entered the penitentiary. The physician says: "It may appear strange that we have so heavy a percentage of deaths from consumption, but to successfully treat consumption or those predisposed to the disease requires surroundings that are not to be found in an institution of this kind."

7. The physician of the Jefferson City penitentiary reports that in 1887, he treated 21 cases of phthisis and 2 of intestinal tuberculosis, and in 1888 1 of acute phthisis and 11 of phthisis pulmonalis. Among the deaths in 1887 was 1 from intestinal tuberculosis and in 1888 1 from traumatic pneumonia. The warden's report shows three deaths not noted by the physician, viz., 1 from apoplexy, 1 "died in cell," and 1 killed by guard. The percentage of phthisis is surprisingly low.

8. Of the 851 new convicts received during the year at Sing Sing, 598 were in good health and 253 were "partially disabled." The percentage of deaths on the total number of convicts is 0.67, and on the daily average 1.06. Of those who died of phthisis the shortest confinement was 2 months, and the longest 26 months.

9. The physician at Auburn says: "The mortality has

been abnormally large as compared with former years. Convicts have been transferred to this prison during the past year in the last stages of consumption, who were carried from the cars to the hospital, unable to walk or help themselves and who died shortly afterwards." There were also 3 deaths from scrofula, 1 from pneumonia, and 2 by suicide. The terms of imprisonment of the victims of phthisis ranged from 3 to 42 months, being over 1 year in 11 cases. The previous health of only 2 is reported as fair, the rest being poor or very bad; the previous habits of 6 were temperate, of 2 moderate, and of 9 intemperate.

10. There was also 1 death from hemoptysis at Clinton. The confinements were respectively 3, 25, 31, and 43 months.

11. Of all the reports which I have examined, that of the Eastern penitentary of Pennsylvania, situated at Philadelphia, is the most interesting. The report of Dr. W. Duffield Robinson, the physician in charge, is complete. It shows that of the 560 convicts received during the year, 345 were in unimpaired and 215 in impaired physical health; 59 were consumptives; 121 were from families in which consumption was strongly hereditary (313 deaths from that disease having occurred in their immediate families). Of the total convict population in 1887 (1691), 126 were consumptive and the average number of these under treatment was 66. Of the 21 who died from consumption, 10 were unable to give a reliable family health history, and 11 gave a family history of consumption. All but 2 of the 21 were afflicted with the disease on their admission, their health being rated as: bad 11, poor 1, impaired 4, and fair 5 The length of confinement ranged from 4 to 90 months, most of the cases being between 1 and 2 years. There was 1 death by suicide. Dr. Robinson says: "In those convicts in whom it is found on reception that there is a strong

hereditary tendency to consumption or that it already exists, appropriate care to prevent its development or progress is taken by securing for the convict appropriate work, medication, and special gymnastic exercises for the benefit of the lungs." He justly says: "With the exception of the simple treatment of disease the work of the medical officer of the penitentiary is of so distinct a character and requires such special study and experience to secure accuracy in his interview and investigation work as to be almost a distinct profession." This penitentiary is the only one in the United States conducted on the cellular or solitary system. Whatever may be said in behalf of that system from a monetary or disciplinary standpoint, the fearful ratio of mortality from phthisis would indicate that it is not to be recommended from a sanitary point of view.

12. The total cases of phthisis treated in the hospital at Alleghany during 1887 were 14, of whom 5 were returned to cell, 2 discharged from prison and 3 remained sick. During 1888, they were 19, 15 being returned to cell and 2 remaining sick. In 1887, there was 1 death from hemoptysis. Those who died from phthisis had been confined respectively 32, 64, 3, 30, 49 and 61 months. The physician says: "It would seem that the regularity of prison treatment seems to prolong life when suffering from a pronounced type of disease."

13. There are 8 convicts now in Huntsville prison with symptoms of phthisis.

B. HOW TO LOOK FOR TUBERCLE BACILLI IN SPUTUM.

The following procedure, which I have translated from Kunze's *Grundriss der Praktischen Medicin*, is Ehrlich's method somewhat modified:

Press a little of the suspected sputum between two cover-glasses so as to get a very thin layer. Dry the cover-glasses separately, either by moving them through the air or holding over a flame, or by passing a few times through the flame. This fixes and dries the preparation. Place some drops of aniline oil in a reagent glass half filled with water, shake, and filter into a watch glass. Add several drops of an alcoholic solution of fuchsin or methyl violet to the contents of the watch glass till they are markedly colored. Warm this mixture till it begins to smoke. Place the cover-glass with the dried sputum, face downwards, on the warm liquid and let it float for from three to five minutes. Remove and rinse in alcohol, acidulated with nitric or hydrochloric acid, until very slight traces of color remain; then rinse in ordinary alcohol (70 or 80 per cent). Dry the cover-glass as before by holding above a flame, clean it where necessary, add a little pure glycerin, and set under the microscope. An enlargement of 400 diameters will show the bacilli if present.